INSTRUCTION MANUAL

CT - 70

Portable Frequency Counter

- Portable battery power
- 3 ranges
- Gate indicator
- 7 digits

ramsey electronics

BOX 4072 • ROCHESTER, NY 14610 • 716/271-6487

INTRODUCTION: The CT-70 frequency counter uses an all new LSI design to give high performance at a reasonable cost. Three frequency ranges provide coverage from audio to the UHF frequencies, while internal preamps assure high sensitivity.
Operating ease is enhanced by locating all controls and the single input jack on the front panel. The unit is completly portable and can function from 2-4 hours from its built in battery supply.

Specifications

Frequency Range:	10 hz to 5.5 mhz (6 mhz range) 50 hz to 55 mhz (60 mhz range) 10 mhz to 550 mhz (600 mhz range)
Sensitivity:	less than 50 mv to 150 mhz less than 150 mv to 500 mhz
Resolution:	1.0 hz (6 mhz range) 10.0 hz (60 mhz range) 100.0 hz (600 mhz range)
Input Impedance:	1 meg ohm, 20pf (6 and 60 mhz) 50 ohms (600 mhz range)
Input Protection:	6 and 60 mhz range; 150 VAC to 10 mhz, 50VAC to 60 mhz 600 mhz range; 5 VAC
Time Base:	5.24288 mhz, temperature compensated TCXO 1.0 ppm 20^{o}-40^{o} C
Display:	7 digit, 0.4" Height Automatic decimal placement
Power:	8-15V AC/DC @ 250 ma max or 4 'AA' size nicad batteries
Size, Weight	5" x5" x 1½", 1 pound with batteries

Operation: Operating the CT-70 counter is very simple, easily used front panel switches control all counter operation. A single front panel input jack eliminates the need to manually switch cables between ranges. A description of the front panel controls is following:

GATE: OFF position turns off the counter.
1.0 sec position selects a one second gate period. The gate period is the time interval over which input pulses are counted.
0.1 sec position selects a one-tenth second gate period.
The faster gate period allows a faster updated count-at the expense of less resolution.

RANGE: 6 mhz position enables the counter to measure signals up to 6 mhz with one hertz resolution (1 sec gate).
60 mhz position enables the counter to measure signals up to 60 mhz with 10 hz resolution (1 sec gate).
600 mhz position enables the counter to measure signals up to 600 mhz with 100 hz resolution (1 sec gate).

INPUT JACK: BNC type jack for probe or antenna input.

GATE LIGHT: Indicates when the counter is actually measuring input signals- gives a visual indication of gate time and counter operation.

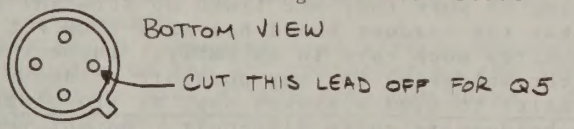
CONSTRUCTION NOTES: Use a small tipped iron for assembly. A power rating of 30-50 watts is ideal. Do not use a soldering gun! Do not use any sort of additional solder flux, use only a good grade of rosin core solder. Proper soldering techniques are important! Each joint should be shiny and completly surround the lead wire. There should not be just a slight dab of solder barely held on to the lead. Don't be afraid of damaging a component due to too much heat, modern day semiconductors can withstand more heat than your iron can put out! Use enough heat to form a good solid joint, a quick touch of the iron is usually not enough. The main PC board has plated thru holes, thereby eliminating the need to solder top side of the board. This, however, makes removing a part more difficult, so follow the directions closely.

Note that most parts stand upright on end. DO NOT mount these parts flat, to do so may cause unnecessary shorts between component leads. Keep component lead lengths as short as possible.

DIRECTIONS

Assembly: Unpack all parts and check against parts list for error, notify Ramsey Electronics immediately of any discrepancy. Review all details before beginning construction. Check off each step as you go along.
Warning Note: Double check your work after each step, checking for correct parts placement, good solder joints and being sure that no solder bridges have been made. Remember the small amount of time spent double checking your work will save you hours of difficult trouble shooting and maybe even save the cost of parts that may be damaged by assembly errors.

1) Locate main counter P.C. board and install the 28 pin socket for U5 and the two 14 pin sockets for U3 and U4, then install the two 16 pin sockets for U2 and U1.
2) Install C1,C2,C3, C10 and C16; .001 UF
3) Install C4; 100pf and C17; 47PFD
4) Install C5 thru C9 and C18
5) Install C11; 1,000 ufd and C15; 220 ufd- Note polarity Be sure C11 is seated firmly against P.C. board.
6) Install C13; 4-40 PFD trimmer
7) Install C12 and C14. These values may vary and are matched to the crystal used. See parts list for exact value.
8) Install CR1 thru CR8; IN4148 type small glass signal diode. Note: These diodes stand upright. Check polarity.
9) Install CR11, CR12 and CR13; IN4003 type large 1 amp diodes. These diodes stand upright. Check polarity.
10) Install diode bridge WO4M. Note position of 'plus' markings on layout and the diode bridge.
11) Install Q1 and Q5 transistors - Note positions. Clip off the ground lead of Q5 as shown before installing.
12) Q1 is to be installed using all four leads

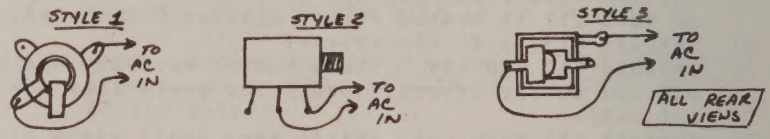


13) Install Q2, FET, Q3, 2N5771, Q4 and Q6 both 2N3906. Note positions.
14) Install R1, R28 and R36; 10K ohms. Note that all resistors on the main board stand upright.
15) Install R2, R11, R14, R15, and R16; 470 ohms
16) Install R3, R10, R17, R18, and R19; 270 ohms
17) Install R4; 100K, R5; 1 Meg and R8; 51 ohms
18) Install R6, R12, R13; 1K and R7; 10 ohms
19) Install R9; 150 ohms, R27; 22 Meg, R20 and R25; both 100 ohms
20) Install UR-1; 7805 voltage regulator; Bolt regulator to P.C. board before soldering using (1)4-40 screw and nut

21) Install Y1; 5.24288 mhz crystal
22) Insert U1; scaler, U2; 10116,U3; 74196; U4; 7207A and U5; 7208 into there sockets, be carefull to align their dots (pin 1 locators) correctly. Check to be sure none of the IC pins are bent under the body of the IC.
23) Mount the battery holder to the main PC board using the special double sided tape (looks like wax paper). Peel off both paper sides and press down firmly to make sure the holder is seated firmly. Solder the red and black leads to the '+' and '-' holes.

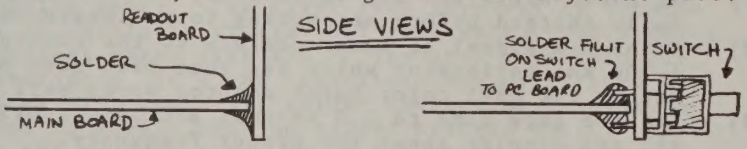
24) Locate the 4" length of 2 conductor cable (length not critical). Strip back about ¼" of insulation at both ends and tin all 4 exposeds leads.
25) Solder the two leads at one end of the 2 conductor cable to the two holes labeled "AC IN".
26) Solder the remaining two leads at the other end of the two conductor cable to the power jack (J2) as shown.

NOTE THAT 3 DIFFERENT JACKS MAY BE USED.... SELECT THE ONE THAT MATCHES



27) Set main PC board aside and locate the read-out board.
28) Install R21 thru R24, R26, and R29 thru R35; all 10 ohms. Note that the resistors lie down flat and do not stand upright.
29) Install CR9 and CR10. Note polarity. These diodes lie flat and do not stand upright.
30) Install the seven readouts (DS1 thru 7). Note the position of the ridges on the top of the readouts. Seat all readouts firmly against the P.C. board. Before soldering be sure they are lined up straight and even. Note that the readout board has many fine P.C. traces and requires much care in assembly. Inspect each joint after soldering for any possible bridges. It is much easier to find mistakes now, as troubleshooting is solder bridges is quite difficult. Do not rush this portion of assembly!
31) Install CR15. Note that the longest lead is inserted in the hole closest to R26. The tip of the led should not extend beyond the readouts.
32) Install the two slide switches as shown in layout. Be sure the switches are seated all the way and that the guide pins are inserted in their holes in the P.C.board. If the switches are not seated correctly, they will cause assembly problems later. Note that the connections that have to be soldered are very small and close together. Care must be taken not to cause any solder bridges. Do not cut the switch leads after soldering.

33) The readout board mounts at a right angle to the main board with solder pads and switch leads providing both mechanical support and electrical connection between the two boards. The readout board is placed against the main board so that the solder pads on the readout board line up with the solder pads on the main board. Note that there are two sets of pads on the readout board. One set connects to the top of the main board the other set to the bottom (solder side) of the main board. Solder the bottom row of the readout pads and switch leads flush with main board between the pads on the readout board. Check to be sure the two boards are perpendicular and not tilted, then solder all remaining pads. Use enough solder to provide a good mechanical connection, but don't cause any solder bridges between adjecent pads.



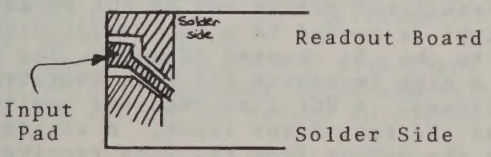
34) Locate the front panel and mount J1, the BNC connector and solder lug. Bend the end of the solder lug out away from the front panel. Be sure to use the lockwasher provided.

35) Locate the bottom half of the plastic housing. This part has the two recessed holes. If the tilt bail is to be used refer to the directions provided with the tilt bail kit. If the tilt bail is not used mount the 4 rubber feet in the out side corners of the housing. Slide the front panel into the groves provided in the front of the bottom housing.

36) Mount the main board to the bottom housing using 4,4-40 screws. Be sure the switches extend thru the holes in the front panel. Do not over tighten the mounting screws.

37) Using a scrap conponent lead wire, solder one end to the solder lug and the other end to the ground of the main PC board closest to the ground lug. Keep the wire as short as possible.

38) Use another scrap component lead wire to connect the center conductor of the BNC connector to the input pad on the solder side of the read out board. Keep this lead as short as possible.



39) Locate the rear panel and install the power jack. The rear panel can then slide into the rear slots.

40) Peel the protective coating off the red lens filter and place it between the readouts and the front plate.

41) If the unit is to be battery operated, make sure the power switch is in the off position, then insert the batteries. Note the polarity of each cell.
42) Now is the time to check over the IC positioning. Are the IC's inserted backwards (note location of Pin 1)? Are any leads bent under the body of the IC and not inserted into the socket?
43) The unit is now ready for calibration. After the unit is calibrated the top cover can be installed using the two 1" long phillips head screws. Do not over tighten. If problems exist refer to troubleshooting hints and theory of operation.

Calibration:

1) If nicad batteries are to be used, be sure they are fully charged before attempting to calibrate the counter.
2) Connect a signal of know accuracy to the counter input. A 100 khz calibrator which has just been zero beated to WWV or the CB-1 color burst adaptor works well.
3) Set the gate time to 1.0 seconds and adjust C13 until the display shows the proper frequency.

Theory of Operation:

General: Regardless of the type or complexity of a frequency counter, all instruments measure frequency by counting input pulses with respect to a known frequency or time base. The time base generates a precisely controlled time interval, selectable to be one second or one-tenth of a second. During this period, the counter is enabled and input pulses counted. When the time period is up, the number of pulses counted is then displayed. A long gate period allows more pulses to be counted, and the more pulses counted the better the resolution. The limiting factors governing resolution are the number of digits in the display and the tolerable gate period. Usually 1.0 hz is the best resolution practical for an easy to read updated count. Of course it is not always necessary to read frequency to a hertz or wait for a one second count. By selecting a shorter gate period, you can reduce the display update time and get a faster reading display, but at the expense of poorer resolution.

Detailed Theory: Input signals to the CT-70 are routed by switch S1 to either the prescaler, or direct input. The prescaler uses a VHF transistor preamp and an ECL decade divider. The divider output is routed to a TTL decade divider, pulse shaper and then to the LSI counter IC chip. The direct input consists of a high impedance FET with bootstrap bipolar transistor follower. A ECL line receiver amplifier/schmitt trigger follows the transistor input. A standard ECL to TTL converter takes the output from the line receiver and changes it to the required TTL level required by the LSI counter chip and pulse shaper. The time base consists of another LSI chip. All gate periods are generated as well as the various housekeeping functions such as multiplex, strobe, gate and reset signals.

A transistor driver looks at the gate signal and lights a gate LED to indicate when the gate is open and pulses being counted. The power supply is a simple rectifier which will accept AC or DC. A capacitor filters the rectifier's output and a 7805 regulator provides a stable 5 volt power source. When nicad batteries are used, they power the counter directly and are charged via the unregulated rectifier output.

Trouble Shooting Hints: The first step involved in trouble shooting is to carefully examine all your work. Check parts placement against parts list and PC layout. Make sure all diodes, transistors, IC's and capacitors are orientated correctly. Above all, check all solder connections! Examine all P.C. runs to verify that no solder bridges exist. Carefully check the readout board as it has quite a few close foil runs.

Problem: Entire display doesn't light.
Check: Power supply voltages, connections to readout board, solder bridges across power switch and correct external supply (if used).

Problem: 5V not present.
Check: CR12, VR1, CR13 and battery holder assembly.

Problem: Display lights, but shows odd characters.
Check: All solder joints on readout board- Look closely for bridges.

Problem: Digit not lit
Check: U5 to be sure all pins are seated properly. Check R29-R35.

Problem: Segment not lit in all digits.
Check: U5 to be sure all pins are seated properly.

Problem: Only one digit lit.
Check: U4, Y1, R27, C12, C13 and C14.

Problem: Display Flickering.
Check: Power supply voltage. Note that when unit is used for extended periods from AC adaptor some power is used from the batteries (nicads only). A full charge can only be provided when the power is in the 'off' position.

Problem: No gate light.
Check: Q6 and R26. Also check solder pads at junction of readout board and main board. Be sure no solder has fallen to bottom row of pads.

HOW TO USE YOUR COUNTER

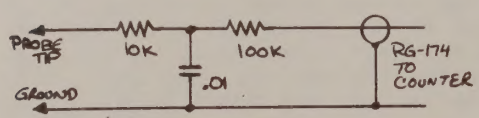
Using your counter is usually just as easy as connecting the signal to the input jack and counting. However, in some instances, such as noisy signals or low frequencies, care must be taken in applying the signal to the counter. The counter not only has a high input impedance but also high sensitivity. Noise accompanying the desired signal may fall with in the counter's sensitivity and frequency limits, and be counted. This signal plus noise input is amplified and counted within the instrument , and produces a jittery, unstable display. The solution to this problem is to attenuate the signal plus noise to the level where the noise is below the counter threshold. A scope X10 probe is ideal for this purpose, an easily constructed probe of this type is described later on.

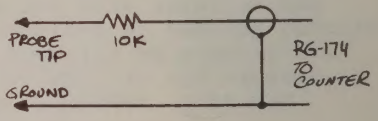
Another problem area is ringing at the counter input. Consider the coax cable from the signal to be measured to the input jack, it's a transmission line, just like your antenna coax on a transmitter. Being so, a standing wave phenomenom can occur if impedances are mismatched. If a signal from a low impedance source is presented to the coax cable, and the cable is connected to the high impedance counter input, the signal will be mismatched. This mismatch will cause the signal to reflect from the input and return, causing, again, an unstable display.

Yet another consideration is that of ground loops. If your counter probe is grounded to the circuit to be measured, and the counter case also grounded (whether physically or induced) a ground current along the cable can exist. This ground current will produce a voltage which, if it is AC, will be counted.

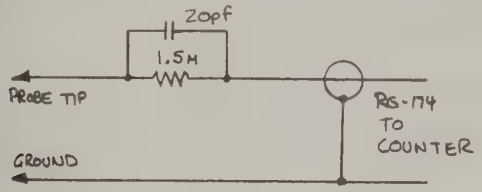
Fortunately, most of these problems are easily solved by thoughtful selection of coupling the input signal. This involves determing just what sort of signal you are attempting to measure.

For Low Frequency (less than 20 khz) Measurement: Low frequency measurements are usually upset by excessive noise riding on the input signal, ground loops or ringing. Even though you may feel the signal is very "clean", the counter can count up to VHF and noise or ringing will be counted. The use of a low pass filter will prevent any high frequency noise or ringing to be presented to the counter input. Preventing a ground loop is not quite as easy as using a different probe. Generally, providing a ground path other than the probe's ground will solve the problem. Two simple low pass probes are shown below:

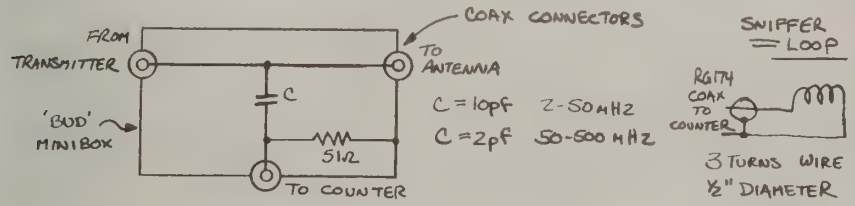




For General Usage (20 khz to 60 mhz) Measurement: The majority of signal measurements are usually within this range. Ringing and noise are the chief culprits in measurement. The only way to counteract these undesirables is to damp the ringing and/or attenuate the noise(with the signal too, unfortunately). A simple X10 oscilloscope probe works well to attenuate noise as well as providing a less loading probe. If the noise is at a 10 mv level and signal at 1 volt, the X10 probe will reduce the noise to 1 mv and the signal to 100 mv, thus the noise is out of the counter's sensitivity range, while the desired signal isn't. The X10 probe or high impedance probe will also generally damp out ringing. Another benefit of the high impedance probe is that it doesn't load the circuit being measured by the input cable's capacitance. This is especially important when measuring oscillators or amplifiers. A simple high impedance probe is shown below:



For Direct Transmitter Measurement: Measuring a transmitter requires coupling enough transmitter energy into the counter for a stable count and not so much as to exceed the counter's safe input. Generally, for VHF work, a small 18" whip antenna will pick up a transmitter from 5 to 10 feet away. Direct connection to the transmitter can be made via a coupling box or pick up loop. The pick up loop is simply a few turns of wire wrapped around the transmitter's antenna coax and fed to the counter. The coupling box requires breaking into the transmitter's antenna coax. Schematic is shown below:



FREQUENCY COUNTER ACCESSORIES

CT-70 110VAC power adapter, AC-1		$ 3.95
CT-70 Nicad battery pack and adapter		12.95
CT-70 External power cable, 8-15VAC/DC		2.95
DC Probe, direct input		12.95
High Impedance Probe, low circuit loading		15.95
Low Pass Probe, for audio measurement		15.95
High Pass Probe, reduces low freq pickup		15.95
Collapsible whip antenna (20 inches)		7.95
CB-1 Color Burst Adapter for calibration, high accuracy, typically .001ppm		14.95
PS-2 Audio scaler, multiplies audio signals times 10 or 100, gives 0.1 or 0.01 hz resolution with 1 sec gate	wired kit	39.95 29.95
Counter preamp, 25db gain	kit 34.95	wired 44.95

Warranty

All parts used in the CT-70 counter are warranted to be free from any defects for a period of 90 days. Parts found to be defective within this period will be replaced promptly without charge upon receipt for inspection at the factory. After the warranty period has passed, parts may be purchased per the price list. Ramsey Electronics cannot be held responsible for faulty workmanship during assembly or damage/harm caused by construction or installation errors. Units obviously misused or modified are not covered by this warranty. Units returned for refund must be in original form and be sent back within 10 days.

Repair Service

Assembled CT-70 kits may be returned for repair and calibration to factory standards for a fee of $20.00. This fee covers repair, calibration, shipping, insurance, handling and a service report on difficulties found. CT-70 units assembled with paste flux, acid core solder or soldering guns will not be accepted. Ramsey Electronics reserves the right to refuse repair on unreasonably constructed units.

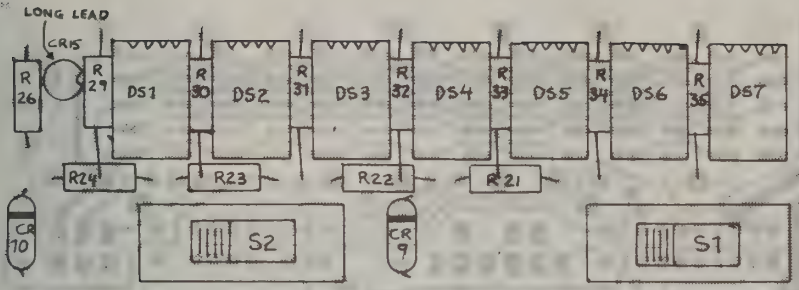
Pack all returns adequately and insure for your own protection.

CT-70 Combined Parts List

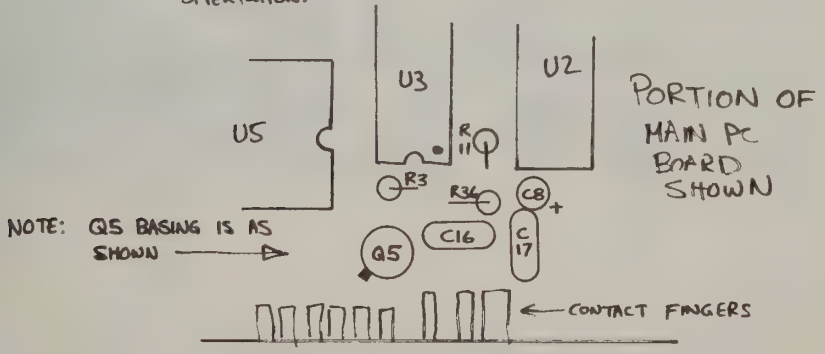
Designator	Description	Price(ea)
C1,C2,C3,C10,C16	.001	$ .15
C4	100 pf	.15
C5,C6,C7,C8,C9,C18	.22 to luf	.40
C11	1,000 uf	.95
C12,C14	15-47 pf, Typical values	.25
C13	4-40 pf trimmer	.65
C15	220 uf	.45
C17	47 pf	.25
CR1-10	IN4148 Type, Small Signal Diode	.15
CR11-13	IN4003,1 Amp Power Type Diode	.15
CR14	W04M Diode Bridge	.75
CR15	Mini-Red LED	.20
DS1-7	FND357,359 Readouts	1.25
J-1	BNC Connector	1.90
J-2	Subminiture Phono Jack	.60
Q1,Q5	MRF502 or 2N5179	1.10
Q2	2N5484/5 or MPF102	1.00
Q3	2N5771 PNP "	1.00
Q4,Q6	2N3906 PNP "	.35
R1,R28,R36	10K ohms,Brn-Blk-Org	.10
R2,R11,R14,R15,R16	470 ohms,Yel-Vio-Brn	.10
R3,R10,R17,R18,R19	270 ohms,Red-Vio-Brn	.10
R4	100K ohms,Brn-Blk-Yel	.10
R5	1 Meg ohms,Brn-Blk-Grn	.10
R6,R12,R13	1K ohms,Brn-Blk-Red	.10
R7,R21,R22,R23,R24	10 ohms,Brn-Blk-Blk	.10
R26,R29-R35	10 ohms,Brn-Blk-Blk	.10
R8	51 ohms,Grn-Brn-Blk	.10
R9	150 ohms,Brn-Grn-Brn	.10
R20,R25	100 ohms,Brn-Blk-Brn	.10
R27	22 Meg,Red-Red-Blu	.10
S1,S2	Slide Switch, 3 position	2.15
U1	11C90, or SP8680B Prescaler IC	13.50
U2	10116, ECL Amplifier IC	1.25
U3	74196, TTL Decade Counter	1.50
U4	7207A, Oscillator Controller	4.95
U5	7208, MOS-LSI Counter IC	17.95
UR-1	7805, 5V voltage Regulator	1.00
Y1	5.24288 mhz crystal	6.00

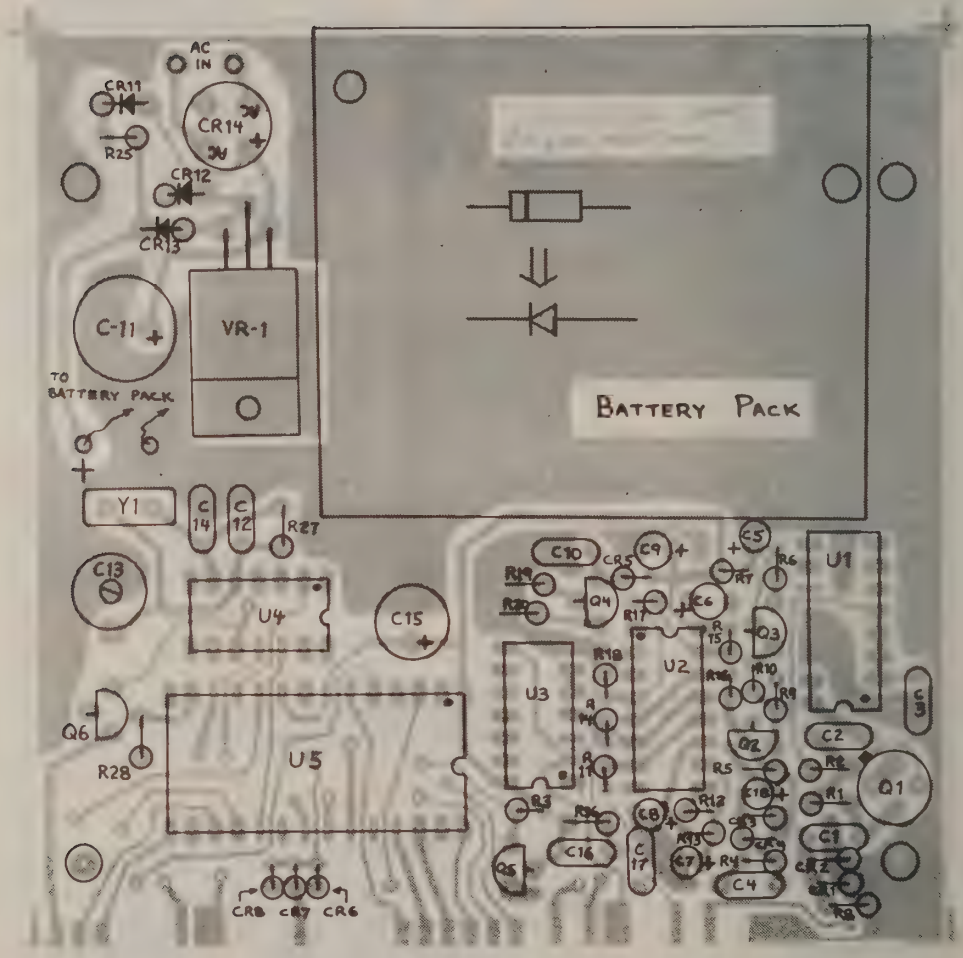
Non- Referenced Items

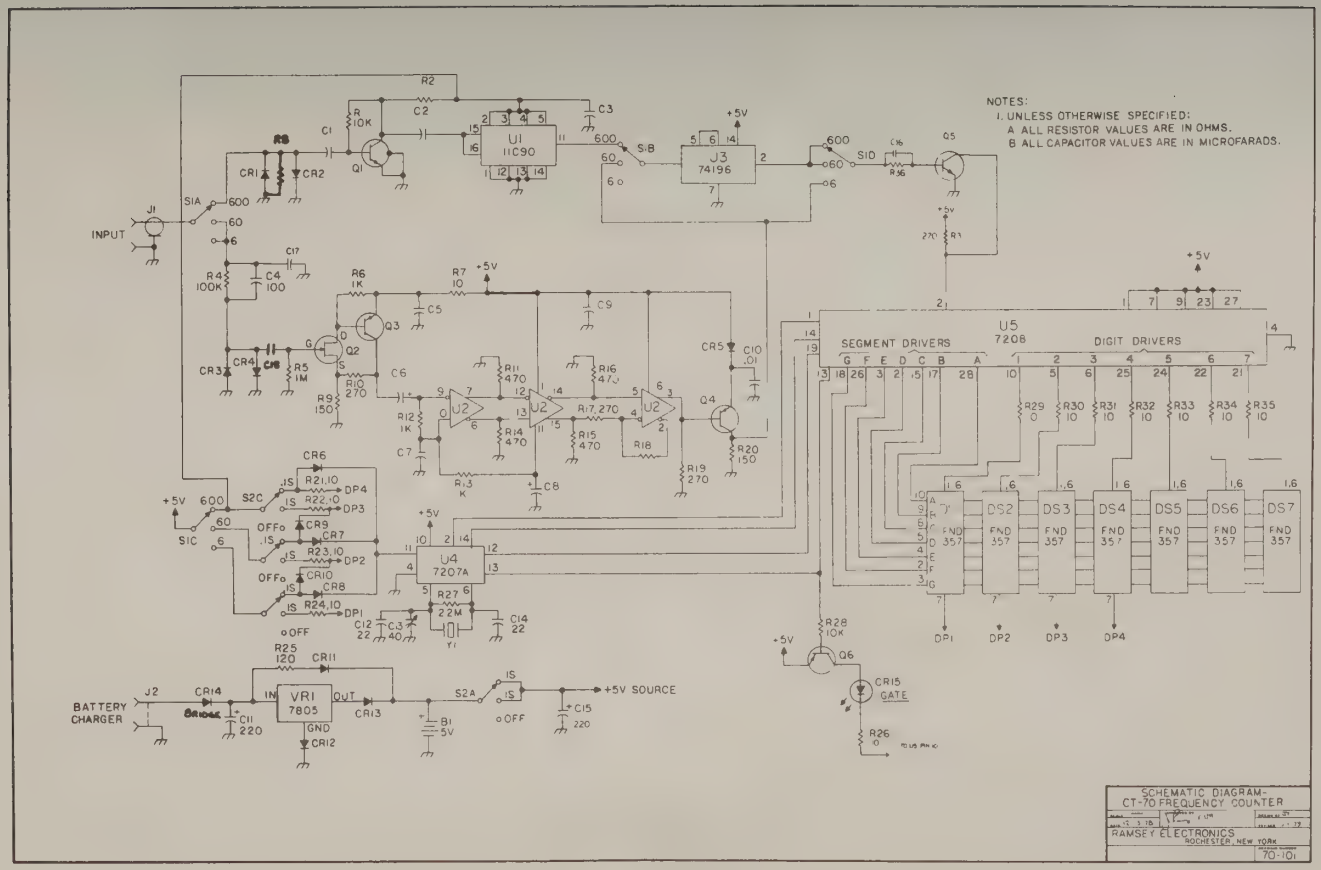
Sockets, Set; 1-28 pin, 2-14 pin, 2-16pin	$ 2.30
CT-70 Counter PC Board	$ 15.00
CT-70 Display Board	$ 8.00
Hook up Wire, 4" 2 conductor	$ .15
Phillips Head screws, 1 inch long, 2 pcs	.30
Solder Lug, 3/8 hole size	$ .10
Rubber Feet, strip of four,Pressure Sensitive	$ .50
Red Lens, 3-7/8"x 3/4"	$ .50
4-40 screw, Qty 5	$ .35
4-40 nut, Qty 1	$ .10
CT-70 Housing, ABS Plastic, Top and Bottom(no lens)	$ 8.50
CT-70 Front Panel, Punched, Labeled	$ 3.90
CT-70 Rear Panel, Punched	$ 2.90
Battery Holder, 4- AA Cell Type	$ 1.80
Double sided tape, 2" X 1"	$ .25



!MPORTANT
NOTE: A different type of transistor is supplied for Q5 — it has a different case, see diagram below for proper orientation.




AC IN
CR11
R25
CR14
CR12
CR13
C-11
VR-1
TO BATTERY PACK
BATTERY PACK
Y1
C 14
C 12
R27
C13
U4
C15
Q6
R28
U5
CR8 CR7 CR6
C10
CR5
C9
C5
R19
R20
Q4
R17
C6
R6
U1
R7
R15
Q3
U3
R18
U2
R16
R10
R9
C3
R14
R11
Q2
C2
R5
R2
Q1
C18
R1
R3
R12
C8
C19
C1
C16
C 17
C7
R13
R4
C4
CR2
CR1
R8
Q5


NOTES:
1. UNLESS OTHERWISE SPECIFIED:
A ALL RESISTOR VALUES ARE IN OHMS.
B ALL CAPACITOR VALUES ARE IN MICROFARADS.
INPUT
J1
U1 11C90
U2
U3 74196
U4 7207A
U5 7208
SEGMENT DRIVERS
DIGIT DRIVERS
DS1 FND 357
DS2 FND 357
DS3 FND 357
DS4 FND 357
DS5 FND 357
DS6 FND 357
DS7 FND 357
Q1
Q2
Q3
Q4
Q5
Q6
VR1 7805
BATTERY CHARGER
J2
+5V SOURCE
GATE
SCHEMATIC DIAGRAM-
CT-70 FREQUENCY COUNTER
RAMSEY ELECTRONICS
ROCHESTER, NEW YORK
70-101

RAMSEY CT-90

Introduction: The CT-90 is a laboratory quality frequency counter that is capable of use in the lab as well as in the field. Utmost care has been taken in all the design stages to insure that sensitivity and reliabilty were not compromised. The CT-90 has been specifically built for the critical user, as demonstrated by; special timebase options, nine digit display, three gate times, and a count hold feature.

The CT-90 is ideal for portable usage. Leading zero blanking and the micropower oven (optional) allows 2-4 hours of continuous operation using the internal battery supply.

Specifications

Frequency Range:	20hz to 10 mhz (10 mhz range) 100 hz to 60 mhz (60 mhz range) 10 mhz to 600 mhz (600 mhz range)
Sensitivity:	Less than 10 mv to 150 mhz Less than 150 mv to 600 mhz
Resolution:	0.1 hz (10 mhz range) 1.0 hz (60 mhz range) 10.0 hz (600 mhz range)
Input Impedance:	1 meg ohm, 33 pfd (10 and 60 mhz) 50 ohms (600 mhz)
Input Protection:	10 and 60 mhz range; 150 vac to 10 mhz, 50 vac to 60 mhz. 600 mhz range; 5 vac
Time Base:	10.0000 mhz; Standard time base- temperature compensated TCXO- 1.0 ppm 20°-40°C High stability, proportional controlled micro power oven option (OCXO)- 0.1 ppm 20°-30°C
Display:	9 digit, 0.4" height automatic decimal placement
Power:	8-15 v AC/DC at 250 ma max with TCXO, 300 ma max with OCXO, 4 'AA' size nicad batteries
Size, weight:	5" x 5" x 1½", 1 pound with batteries

Operation: Operation of the CT-90 is very simple, simply connect your input signal to the proper input jack (10, 60 mhz or 600 mhz) and select the range and gate time. All switches, except the external time base switch (optional) are mounted on the front panel in easy view of the user. A description of the front panel controls follows.

POWER:
OFF turns the counter off
ON turns the counter on
HOLD stops the clock signals to the counter circuits and holds the count that is displayed.

GATE:
0.1 sec position selects a one tenth second gate period. The gate period is the time interval over which input pulses are counted. The faster gate period allows a faster updated count at the expense of less resolution.
1.0 sec position selects a one second gate period. This position is used when better resolution is required.
10 sec position selects a ten second gate period. This position is used only when extreme accuracy is required and a long term, stable signal is available.

RANGE:
10 mhz position is used when input signals are connected to the 10, 60 mhz input jack. The counter will then count up to 10 mhz with 0.1 hz resolution. (10 sec gate)
60 mhz position is used when the input signals are connected to the 10, 60 mhz input jack. The counter will then count up to 60 mhz with 1.0 hz resolution. (10 sec gate)
600 mhz position is used when the input signals are connected to the 600 mhz input jack. The counter will then count up to 600 mhz with 10 hz resolution. (10 sec gate)

GATE LIGHT:
Indicates when the counter is actually measuring input signals. The gate light gives a visual indication of gate time and counter operation. It is extremely useful when using the longer gate times.

ASSEMBLY DIRECTIONS

Construction Notes:Use a small tipped iron for assembly. A power rating of 30-50 watts is ideal. Do not use a soldering gun! Do not use any sort of additional solder flux, use only a good grade of rosin core solder. Proper soldering techniques are important! Each joint should be shiny and completly surround the lead wire. There should not be just a slight dab of solder barely held on to the lead.

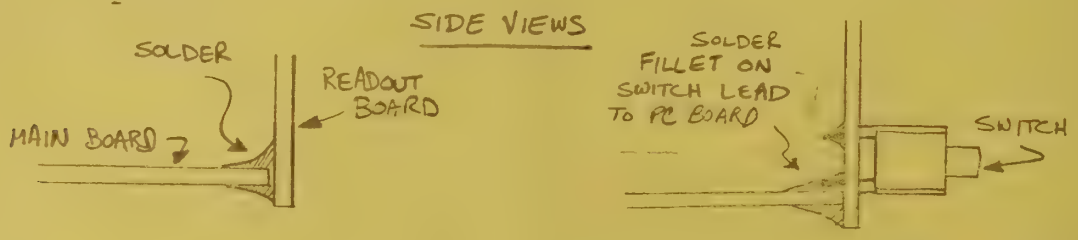
ASSEMBLY DIRECTIONS (continued)

Don't be afraid of damaging a component due to too much heat, modern day semiconductors can withstand more heat than your iron can put out! Use enough heat to form a good solid joint, a quick touch of the iron is usually not enough. The main PC board has plated thru holes, thereby eliminating the need to solder top side of the board. This, however, makes removing a part more difficult, so follow the directions closely. Keep component lead lengths as short as possible. Note that components in the U4,U1 and U2 area must be kept close to the PC board so that the battery holder can be mounted above them

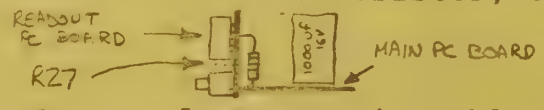
Assembly:

1) Locate the main counter PC board and install the 28 pin socket for U3, the two 16 pin sockets for U1 and U4, and the 14 pin socket for U2.
2) Install C2, C3, C4 and C5; All .01. Do not install C1 at this time.
3) Install C6, 100 pfd and C12, .01.
4) Install C7, C8, C9, C10 and C11; .22 to 10 ufd. Note the polarity on all these capacitors.
5) Install CR1 thru CR6; 1N4148 type small glass signal diodes. Note polarity.
6) Install CR8 thru CR14; 1N4003 type, 1 amp diodes, observe polarity.
7) Install R1, R20, R21, R22, R24, R26, all 10K ohm.
8) Install R2, R10, R12, R13, and R14, R23, all 470 ohm.
9) Install jumper where R3 is located. Use scrap component lead.
10) Install R4; 100 k ohm,and R5; 1 meg ohm.
11) Install R6, R9, R11 and R25; all 1 k ohm.
12) Install R7, R15, R16 and R17: all 270 ohm.
13) Install R8; 150 ohm, Read color coding carefully.
14) Install R18 and R28; both 100 ohms.
15) Install Q1; MRF502, Q2; 2N5484, Q3 and Q4; 2N5771, Q5; 7545 and Q6; 7546. Note the positioning of these transistors before installing. Keep the leads of Q4 and Q1 short so that the total height of each part does not exceed 3/8".
16) Install VR-1; 7805 voltage regulator. Bolt the regulator to PC board before soldering using (1) 4-40 x ¼" screw and nut.
17) Install C15; 1000 ufd and C16; 220 ufd. Be sure both parts are seated against PC board. Note polarity.
18) If you are going to use the standard 1 ppm time base follow steps 19 thru 21. If you are going to use the micro power 0.1 ppm oven proceed directly to step 22. Be sure to read all instructions given with the micro power oven.
19) Install C14 and C17. These part values are matched to the crystal used and may vary. See parts list.
20) Install R19; 22 meg ohms and C13; trimmer capacitor.
21) Install Y1; 10.000 mhz crystal. Note: When using the standard 1.0 ppm crystal time base, diode CR7 is not used. Proceed now to step 24, ignore steps 22and 23.
22) Install the precision oven oscillator module as shown in diagram. Be sure the module is aligned properly and seated firmly against PC board. Note that there are no parts installed or supplied for R19, C13, C14, C17 or Y1.
23) Install CR7 as shown. Note, CR7 is used ONLY with oven option!
24) Install U1; 11C90, U2; 74196, U3; 7216 and U4; 10116 IC's. Be sure that the IC's are installed in the correct sockets and that they are not installed backwards. Are all the IC leads inserted

24) into the socket? It is very easy to have some leads bent under the IC body.
25) Set the main PC board aside and locate the read out board.
26) Carefully examine the readout PC board for any shorts between lands that could have occured in manufacture.
27) Install the nine readouts (DS1 thru 9). Note the position of the ridges on the top of the readouts. Seat all readouts firmly against the PC board. Before soldering be sure they are lined up straight and even. Note that the readout board has many fine PC traces and requires much care in assembly. Inspect each joint after soldering for any possible bridges. It is much easier to find mistakes now, as troubleshooting of solder bridges is quite difficult. Do not rush this portion of assembly!
28) Install CR15; Red LED as shown. Be sure that the long lead is installed in the bottom-most hole.
29) Install the three slide switches as shown in layout. Be sure the switches are seated all the way and that the guide pins are inserted in their holes in the PC board. If the switches are not seated correctly, they will cause assembly problems later. Note that the connections that have to be soldered are very small and close together. Care must be taken not to cause any solder bridges. Do not cut the switch leads after soldering.
30) The readout board mounts at a right angle to the main board with solder pads and switch leads providing both mechanical support and electrical connection between the two boards. The readout board is placed against the main board so that the solder pads on the readout board line up with the solder pads on the main board. Note that there are two sets of pads on the readout board. One set connects to the top of the main board, the other set to the bottom (solder side) of the main board. Solder the bottom row of the readout pads and switch leads flush with main board between the pads on the readout board. Check to be sure the two boards are perpendicular and not tilted, then solder all remaining pads. Use enough solder to provide a good mechanical connection, but don't cause any solder bridges between adjecent pads.

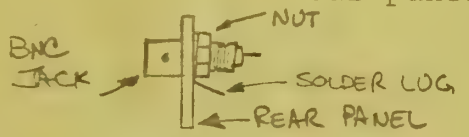


31) Locate R27; 15 ohms. One lead of this resistor mounts on the main board and the other end connects to the read out board at the extreme end. This resistor, therefore stands upright.

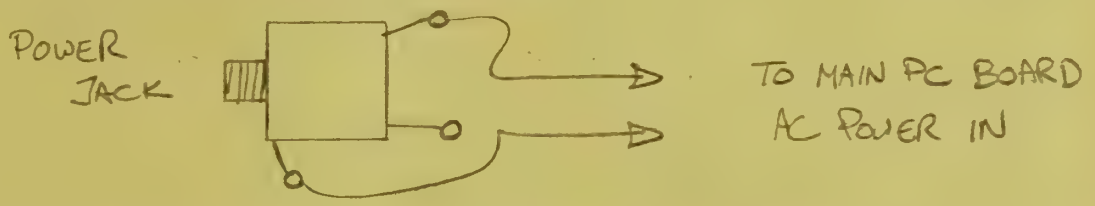


32) Locate the two conductor strip cable and install both leads at one end to the holes marked 'AC'. The other end will be connected later.
33) Locate the battery holder assembly and solder the black and red leads to the holes labeled 'BATT'. (red to plus)

34) Note the location of the battery holder mounting holes and position the battery holder over VR-1 so that the red and black leads face toward the front of the counter (toward readout board). Note which holes in PC board line up with mounting holes in battery holder.
35) Install the two 3/8" standoffs on the componet side of the PC board in the holes that line up with the battery holder. Use two 4-40 x 3/16" screws. Posistion standoffs so they don't short.
36) Mount the battery holder to the top of the standoffs using two 4-40 x 3/16" screws. Be sure not to damage any parts under the battery holder. The two conductor cable from the 'AC' holes should extend out to the rear.
37) Locate the bottom housing. (the half with the two holes)
38) Locate the four rubber feet, peel off the protective paper and mount them in the four corners of the outside bottom cover.
39) Slide the front panel into the groves provided on the bottom housing.
40) Place the main PC board into the bottom housing so that the three slide switches extend thru the switch holes in the front plate.
41) Mount the PC board using the four 4-40 screws. Do not overtighten.
42) Locate the rear panel and mount the miniature phono jack to the center hole.
43) Mount the two BNC connectors to the rear panel. Install a solder lug under each nut.



44) Solder the two remaining leads from the cable connected to the 'AC' holes to the phono jack as shown:



45) Slide the rear panel into the rear slots of the bottom housing.
46) Locate C1; .01, connect one lead to the center of J1 and the other lead to the PC land that connects C2, CR1, and CR2. Keep the leads as short as possible. You may wish to remove the battery holder while doing this.
47) Using a scrap component lead, connect the ground lug of J1 to the ground plane of the PC board. Keep this lead a short as possible.
48) Connect a scrap component lead from the center of J2 to the pad on the main PC board labeled J2. Keep this lead as short as possible.
49) Connect a scrap component lead from the solder lug of J2 to the PC board ground plane. Keep this lead as short as possible.

50) Locate C18; 22 pfd. Connect one lead to the center of J2 and the other lead to the PC board ground plane. Keep leads as short as possible.
51) Locate the red lens and place it between the readouts and the front plate.
52) The unit is now ready for checkout and calibration (note: the precision oven option does not require calibration, it is factory calibrated).
53) If problems occur see the trouble shooting hints and theory of operation. After calibration the top cover can be installed using the two phillips head screws. Do not overtighten. The cover will only mount one way.

Calibration:

1) If nicad batteries are to be used, be sure they are fully charged before attempting to calibrate the counter.
2) Connect a signal of known accuracy to the counter input. A 100 khz calibrator which has just been zero beated to WWV or the CB-1 color burst adaptor works well.
3) Set the gate time to 1.0 seconds and adjust C13 until the display shows the proper frequency.

Theory of Operations:

General: Regardless of the type or complexity of a frequency counter, all instruments measure frequency by counting input pulses with respect to a known frequency or time base. The time base generates a precisely controlled time interval, selectable to be one second or one-tenth of a second. During this period, the counter is enabled and input pulses counted. When the time period is up, the number of pulses counted is then displayed. A long gate period allows more pulses to be counted, and the more pulses counted the better the resolution. The limiting factors governing resolution are the number of digits in the display and the tolerable gate period. Usually 1.0 hz is the best resolution practical for an easy to read updated count. Of course it is not always necessary to read frequency to a hertz or wait for a one second count. By selecting a shorter gate period, you can reduce the display update time and get a faster reading display, but at the expense of poorer resolution.
Detailed Theory: The UHF and VHF inputs have been kept separate to increase the input sensitivity by eliminating switching losses. The UHF signals are feed thru J1, past CR1-CR2 input protection diodes to Q1, the first amplifier/limiter stage. The signal is then sent to U1, divide by ten IC.

The VHF input is much different because it must be of a very high impedance. The signal is feed thru J2, past CR3 and CR4 input protection diodes to the gate of Q2; FET. The combination of the FET and Q3 bootstrap bipolar transistor follower provides the high impedance required. The signal is then sent to the three stage line amp U4. This IC is an ECL device that limits and shapes the signal. Transistor Q4 then converts the ECL level to a TTL level signal that the rest of the counter requires. The input to U2 divider is selected by the range switch.

Its input can come from the UHF section (U4) or the VHF section (Q4). If the 10 mhz mode has been selected U2 is bypassed completely and the signal is sent directly to U3, the counter IC.

The timebase for U3 can be supplied by Y1 and its associated components or by an external timebase. The counter IC will use whichever timebase that has been selected at pin 1. If CR7 is installed, the timebase connected to pin 24 will be used. The counter IC generates all its own housekeeping functions such as multiplex, strobe, gate and reset signals. A logic circuit inside the counter IC senses the scanned readout signals (D0 thru D7) and also the input to pin 14, the gate select input. By comparing these inputs, the counter IC generates the selected gate time. The decimal point is displayed the same way. A logic circuit inside the IC looks at the scanned outputs D0 thru D7 and compares this with the signals selected by S2.

The power supply uses a simple bridge rectifier circuit that will accept an AC or DC input. Regulator VR1 provides a stable 5V power source while R28 and CR12 provide the charging current for the nicads (if used). Capacitors C15 and C16 provided added filtering.

Trouble Shooting Hints: The first step involved in trouble shooting is to carefully examine all your work. Check parts placement against parts list and PC layout. Make sure all diodes, transistors, IC's and capacitors are orientated correctly. Above all, check all solder connections! Examine all PC runs to verify that no solder bridges exist. Carefully check the readout board as it has quite a few close foil runs.

PROBLEM: Entire display does not light;
Check: Power supply voltages, connections to readout board, solder bridges across power switch and correct external supply (if used). Also check the timebase circuit used. If the counter lacks a timebase input the display may blank.

PROBLEM: 5V not present
Check: CR8 thru CR14, VR-1 and battery holder assembly. Check for shorts on the 5V buss. Are any IC's inserted backwards?

PROBLEM: Display lights but shows odd characters
Check: All solder joints on readout board- Look closely for bridges.

PROBLEM: Digit not lit
Check: U3, be sure all pins are seated properly. Check PC traces connecting pins 1 and 6 of readout.

PROBLEM: Segment not lit in all digits
Check: U3, Be sure all pins are seated properly. Check PC traces to readouts for shorts and open connections.

PROBLEM: Only one digit lit.
Check: Timebase circuits, connections to pins 1 and 6 of lit readout. Also look at power supply voltages.

PROBLEM: Display flickering.
Check: Power supply voltages. Note that when unit is used for extended periods from AC adapter, some power is used from batteries (nicads only). A full charge can only be provided when the power switch is in the off position.

PROBLEM: No gate light.
Check: Timebase circuits, Q6 and solder pads at the junction of the readout board and main board. Is the power switch in the hold position?

PROBLEM: No decimal points.
Check: Q5,R27 and S2 connections.

PROBLEM: Only some digits are lit.
Check: Input signal. This unit has leading zero display blanking. The digits before the decimal point will not be turned on until a signal is applied.

HOW TO USE YOUR COUNTER

Using your counter is usually just as easy as connecting the signal to the input jack and counting. However, in some instances, such as noisy signals or low frequencies, care must be taken in applying the signal to the counter. The counter not only has a high input impedance but also high sensitivity. Noise accompanying the desired signal may fall with in the counter's sensitivity and frequency limits, and be counted. This signal plus noise input is amplified and counted within the instrument, and produces a jittery, unstable display. The solution to this problem is to attenuate the signal plus noise to the level where the noise is below the counter threshold. A scope X10 probe is ideal for this purpose, an easily constructed probe of this type is described later on.

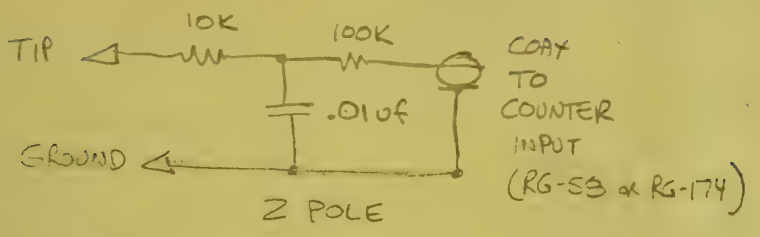
Another problem area is ringing at the counter input. Consider the coax cable from the signal to be measured to the input jack, it's a transmission line, just like your antenna coax on a transmitter. Being so, a standing wave phenomenom can occur if impedances are mismatched. If a signal from a low impedance source is presented to the coax cable, and the cable is connected to the high impedance counter input, the signal will be mismatched. This mismatch will cause the signal to reflect from the input and return, causing again, an unstable display.

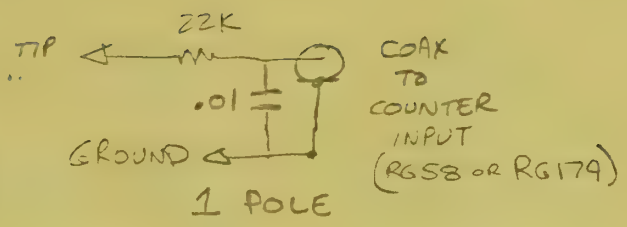
Yet another consideration is that of ground loops. If your counter probe is grounded to the circuit to be measured, and the counter case also grounded (whether physically or induced) a ground current along the cable can exist. This ground current will produce a voltage which, if it is AC, will be counted.

Fortunately, most of these problems are easily solved by thoughtful selection of coupling the input signal. This involves determing just what sort of signal you are attempting to measure.

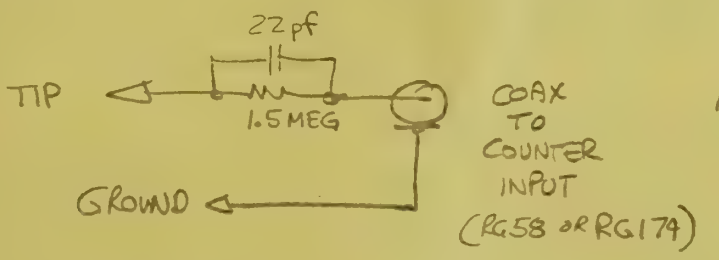
For Low Frequency (less than 20 khz) Measurement: Low frequency measurements are usually upset by excessive noise riding on the input signal, ground loops or ringing. Even though you may feel the signal is very "clean", the counter can count up to VHF and noise or ringing will be counted. The use of a low pass filter will prevent any high frequency noise or ringing to be presented to the counter input. Preventing a ground loop is not quite as easy as using a different probe. Generally, providing a ground path other than the probe's ground will solve the problem. Two simple low pass probes are shown:

LOW PASS PROBES:



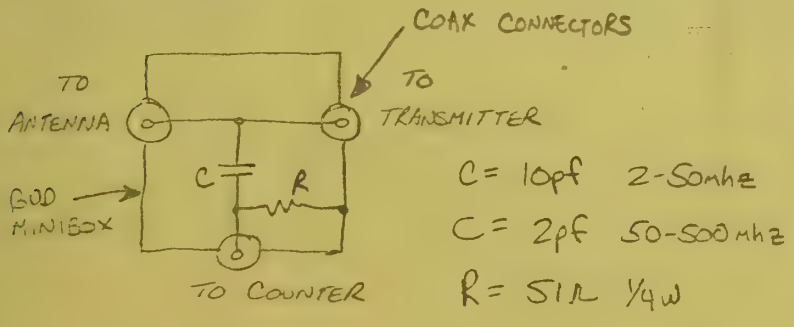


For General Usage (20 khz to 60 mhz) Measurement: The majority of signal measurements are usually within this range. Ringing and noise are the chief culprits in measurement. The only way to counteract these undesirables is to damp the ringing and/ or attenuate the noise (with the signal too, unfortunately). A simple X10 oscilloscope probe works well to attenuate noise as well as providing a less loading probe. If the noise is at a 10 mv level and signal at 1 volt, the X10 probe will reduce the noise to 1 mv and the signal to 100 mv, thus the noise is out of the counter's sensitivity range, while the desired signal isn't. The X10 probe or high impedance probe will also generally damp out ringing. Another benefit of the high impedance probe is that it doesn't load the circuit being measured by the input cable's capacitance. This is especially important when measuring oscillators or amplifiers. A simple high impedance probe is shown below:

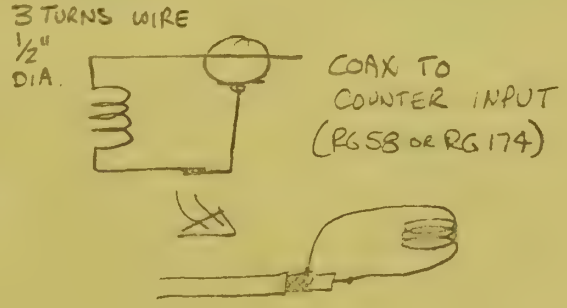


For Direct Transmitter Measurement: Measuring a transmitter requires coupling enough transmitter energy into the counter for a stable count and not so much as to exceed the counter's safe input. Generally, for VHF work, a small 18" whip antenna will pick up a transmitter from 5 to 10 feet away. Direct connection to the transmitter can be made via a coupling box or pick up loop. The pick up loop is simply a few turns of wire wrapped around the transmitter's antenna coax and fed to the counter. The coupling box requires breaking into the transmitter's antenna coax. Schematic is shown below:

COUPLING BOX



SNIFFER LOOP



FREQUENCY COUNTER ACCESSORIES

CT-90 110 vac power adapter		$ 4.95
CT-90 Nicad battery pack and adapter		12.95
CT-90 External power cable, 8-15 VAC/DC		2.95
DC Probe, direct input		12.95
High Impedance Probe, low circuit loading		15.95
Low pass Probe, for audio measurement		15.95
High Pass Probe, reduces low freq pickup		15.95
Collapsible whip antenna (20 inches)		7.95
CB-1 Color Burst Adapter for calibration, high accuracy, typically .001ppm		14.95
PS-2 Audio scaler, multiplies audio signals times 10 or 100, gives 0.1 or 0.01 hz resolution with 1 sec gate	wired kit	39.95 29.95
OSC-1 Micro power proportional controlled oven--- increases stability to 0.1 ppm, 20-30° C, factory wired and calibrated.		59.95
External Timebase input Conversion Kit Allows connection to external time-base,includes BNC connector, switch, electrical parts needed and new rear panel		19.95

WARRANTY

All parts used in the CT-90 counter are warranted to be free from any defects for a period of 90 days. Parts found to be defective within this period will be replaced promptly without charge upon receipt for inspection at the factory After the warranty period has passed, parts may be purchased per the price list. Ramsey Electronics cannot be held responsible for faulty workmanship during assembly or damage/harm caused by construction or installation errors. Units obviously misused or modified are not covered by this warranty.

REPAIR SERVICE

Assembled CT-90 kits may be returned for repair and calibration to factory standards for a fee of $20.00. This fee covers repair, calibration, shipping, insurance, handling and a service report on difficulties found. CT-90 units assembled with paste flux, acid core solder or soldering guns will not be accepted. Ramsey Electronics reserves the right to refuse repair on unreasonably constructed units.

Pack all returns adequately and insure for your own protection.

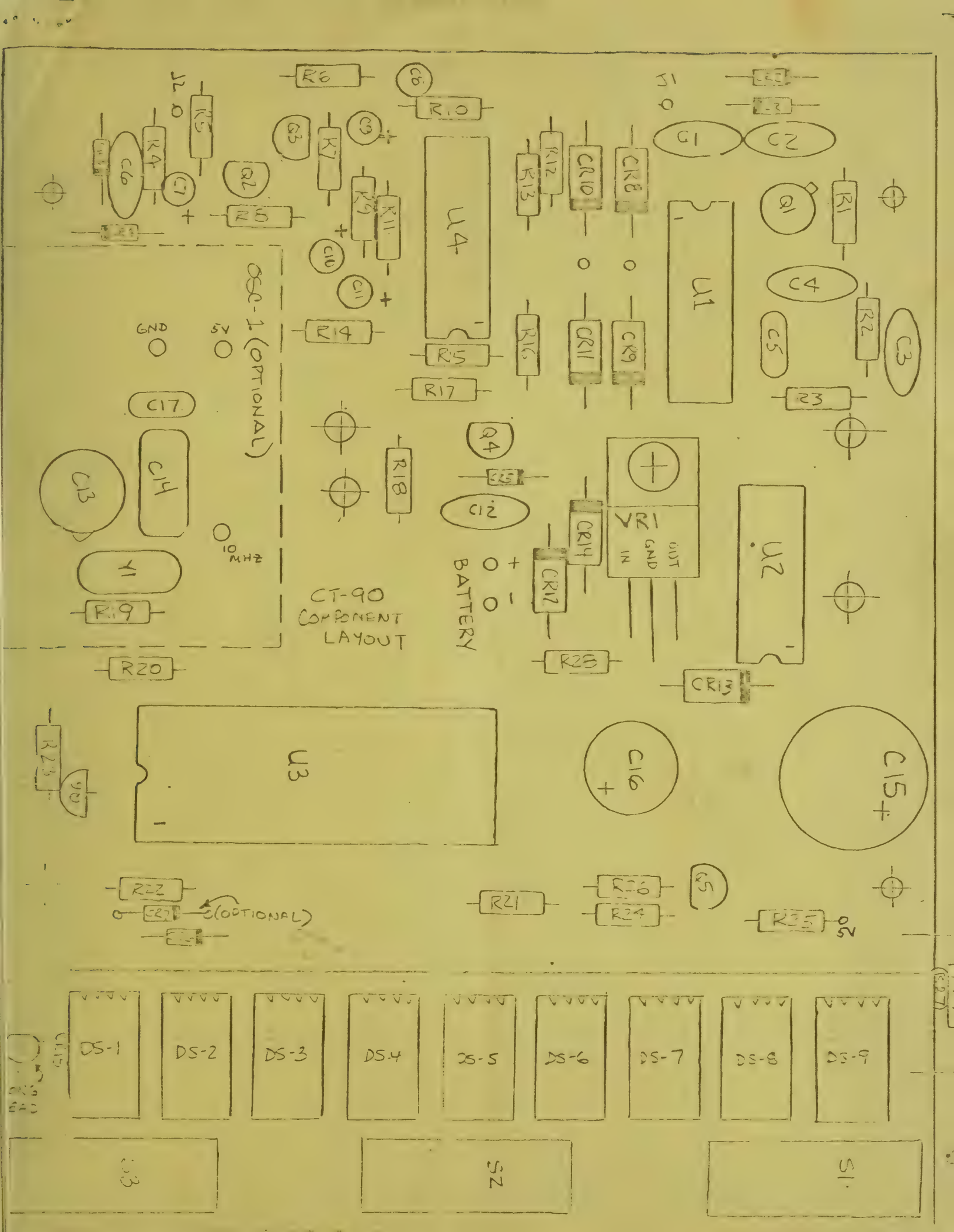
CT-90 PARTS LIST

DESIGNATOR	DESCRIPTION	PRICE (each)
C1 thru C5, C12	.01 uf disc	$ .15
C6	100 pf disc	.15
C7 thru C11	1 to 10 uf	.40
C13	4-40 pf (used in std TB)	.65
C14, C17	22 pf	.25
C15	1000 uf, 16VDC	.95
C16	100 uf, 16VDC	.45
C18	22 pf disc	.25
CR1 thru CR6	1N4148type, small signal diode	.15
CR7	1N4148type, (optional Time base)	.15
CR8 thru CR14	1N4003type,1 amp power diode	.15
CR15	LED, Mini-red	.20
DS1 thru DS9	FND 359,357 Readout	1.75
J1, J2	BNC connector	1.90
J3	Sub miniature phono jack	.60
Q1	MRF502, NPN transistor,2N5179	1.25
Q2	2N5484, FET	1.00
Q3, Q4	2N5771, PNP transistor,2N4258	1.00
Q5	NPN, 7545; 2N3904 type,0139	.35
Q6	PNP, 7546; 2N3906 type,2106,7012	.35
R1,R20-R24, R26	10 k ohms,Brn-Blk-Org	.10
R2,R10,R12, R13, R14	470 ohms, Yel-Vio-Brn	.10
R3	Jumper Wire	---
R4	100 k ohms, Brn-Blk- Yel	.10
R5	1 Meg ohms, Brn-Blk-Grn	.10
R6, R9, R11, R25	1 K ohms, Brn-Blk-Red	.10
R7, R15, R16, R17,	270 ohms, Red-Vio-Brn	.10
R8	150 ohms, Brn-Grn-Brn	.10
R18, R28	100 ohms, Brn-Blk-Brn	.10
R19	22 meg ohms, Red-Red-Blue (STD OSC only)	.10
R27	15 ohms, Brn-Grn-Blk	.10
S1, S2, S3	Slide switch, 3 position	2.15
U1	11c90, High speed decade prescaler IC,8680	13.50
U2	74196, TTL decade counter	1.50
U3	7216, MOS, LSI counter	21.95
U4	10116, ECL Amplifier	1.25
VR-1	7805, voltage regulator, 5V	1.00
Y1	10.0000 Mhz crystal	6.00

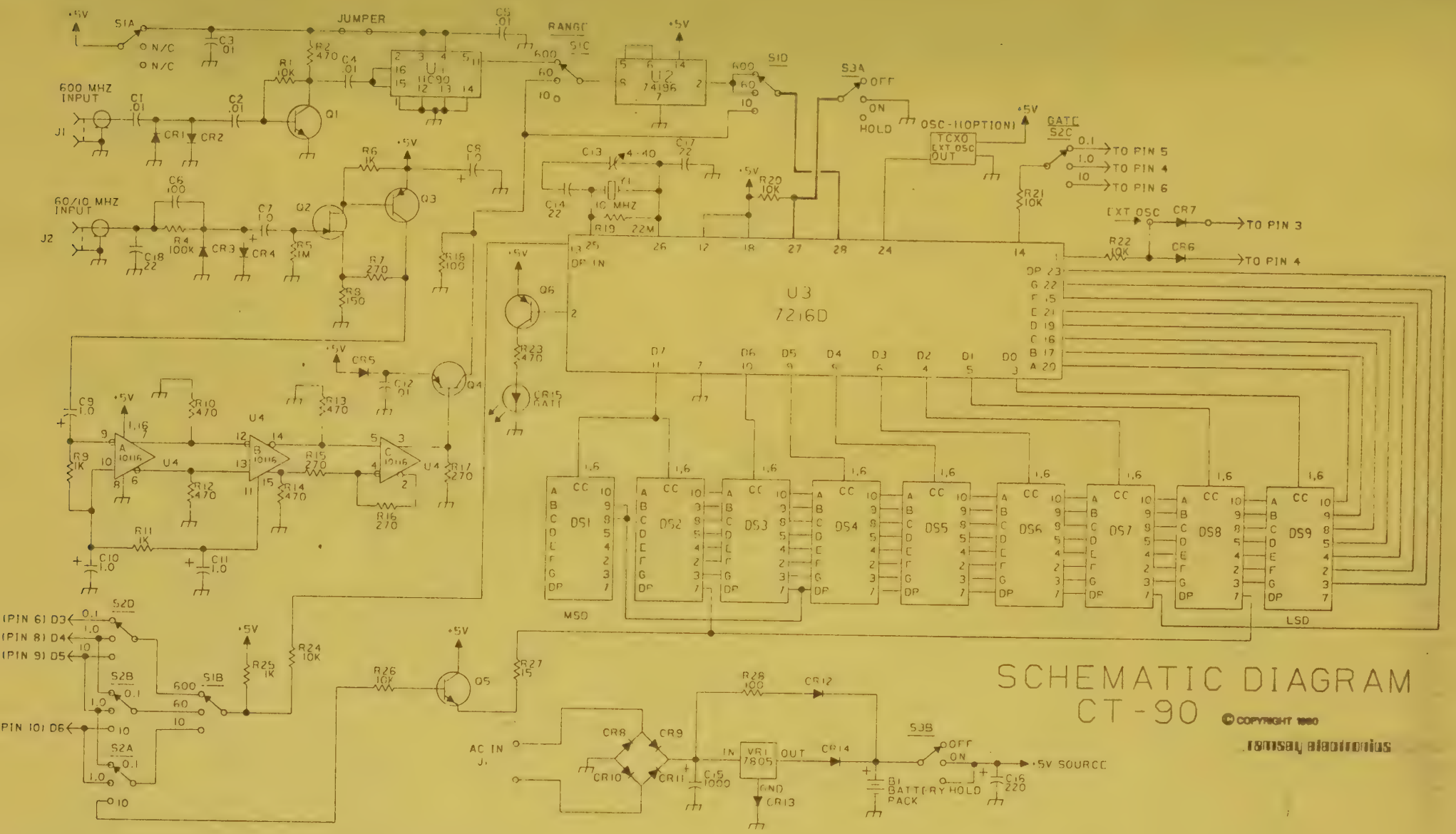
Non- Referenced Items

Socket Set 1-28 pin, 2-16 pin, 1-14 pin	2.15
CT-90 PC board	20.00
CT-90 Display board	8.00
Hook-up wire, 4"- 2 conductor	.15
Phillips head screws, 1", Qty 2	.30
Solder Lug, 3/8" hole size, Qty 2	.10
Rubber feet, strip of four, pressure sensitive	.50
Red lens, 4½" x 3/4"	.50

DESIGNATOR	DESCRIPTION	PRICE (each)
	Non-Referenced Items	
	4-40 x ¼' screws, Qty 5	.35
	4-40 x 3/16" screws, Qty 4	.35
	4-40 x 3/8" standoff, Qty 4	1.00
	4-40 Nut, Qty 1	.10
	CT-90 Housing, ABS Plastic, top and bottom	8.50
	CT-90 Front panel, punched, labeled	3.90
	CT-90 Rear panel, punched	2.90
	Battery holder, 4-AA cell type	1.80
	INTERNAL OPTIONS	
	OSC-1 Micro power, proportional controlled oven Factory calibrated, 0.1 ppm 20-30°C	59.95
	External timebase input conversion kit	19.95



CT-90
COMPONENT
LAYOUT



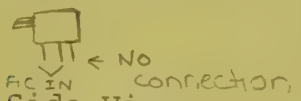
SCHEMATIC DIAGRAM
CT-90

© COPYRIGHT 1980

ramsey electronics

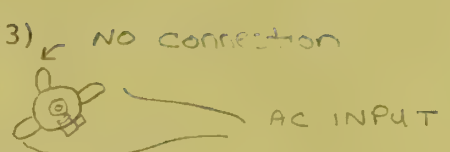
CT-90 REVISIONS

1. Enclosed phono jack may look like:



Side View

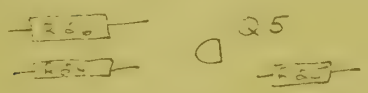
— or —



AC Input Rear View

2. Be sure stand-offs (step 35) do not short 5 volt trace to ground.

3. Q5 is drawn backwards on layout. Should be:



4. R23 is 470 ohms.

5. In step 34, red and black leads may not face forward.

6. C14, C17 may be 47 pf.

7. C12 changed from .01 to 10 uf.

8. CR-5 changed from IN914 to IN4003.

RAMSEY CT-90

Introduction: The CT-90 is a laboratory quality frequency counter that is capable of use in the lab as well as in the field. Utmost care has been taken in all the design stages to insure that sensitivity and reliabilty were not compromised. The CT-90 has been specifically built for the critical user, as demonstrated by; special timebase options, nine digit display, three gate times, and a count hold feature.

The CT-90 is ideal for portable usage. Leading zero blanking and the micropower oven (optional) allows 2-4 hours of continuous operation using the internal battery supply.

Specifications

Frequency Range:	20hz to 10 mhz (10 mhz range) 100 hz to 60 mhz (60 mhz range) 10 mhz to 600 mhz (600 mhz range)
Sensitivity:	Less than 10 mv to 150 mhz Less than 150 mv to 600 mhz
Resolution:	0.1 hz (10 mhz range) 1.0 hz (60 mhz range) 10.0 hz (600 mhz range)
Input Impedance:	1 meg ohm, 33 pfd (10 and 60 mhz) 50 ohms (600 mhz)
Input Protection:	10 and 60 mhz range; 150 vac to 10 mhz, 50 vac to 60 mhz. 600 mhz range; 5 vac
Time Base:	10.0000 mhz; Standard time base- temperature compensated TCXO- 1.0 ppm 20°-40°C High stability, proportional controlled micro power oven option (OCXO)- 0.1 ppm 20°-30°C
Display:	9 digit, 0.4" height automatic decimal placement
Power:	8-15 v AC/DC at 250 ma max with TCXO, 300 ma max with OCXO, 4 'AA' size nicad batteries
Size, weight:	5" x 5" x 1½", 1 pound with batteries

ASSEMBLY DIRECTIONS (continued)

Don't be afraid of damaging a component due to too much heat, modern day semiconductors can withstand more heat than your iron can put out! Use enough heat to form a good solid joint, a quick touch of the iron is usually not enough. The main PC board has plated thru holes, thereby eliminating the need to solder top side of the board. This, however, makes removing a part more difficult, so follow the directions closely. Keep component lead lengths as short as possible. Note that components in the U4,U1 and U2 area must be kept close to the PC board so that the battery holder can be mounted above them

Assembly:

1) Locate the main counter PC board and install the 28 pin socket for U3, the two 16 pin sockets for U1 and U4, and the 14 pin socket for U2.
2) Install C2, C3, C4 and C5; All .01. Do not install C1 at this time.
3) Install C6, 100 pfd and C12, .01.
4) Install C7, C8, C9, C10 and C11; .22 to 10 ufd. Note the polarity on all these capacitors.
5) Install CR1 thru CR6; 1N4148 type small glass signal diodes. Note polarity.
6) Install CR8 thru CR14; 1N4003 type, 1 amp diodes, observe polarity.
7) Install R1, R20, R21, R22, R24, R26, all 10K ohm.
8) Install R2, R10, R12, R13, and R14, R23, all 470 ohm.
9) Install jumper where R3 is located. Use scrap component lead.
10) Install R4; 100 k ohm,and R5; 1 meg ohm.
11) Install R6, R9, R11 and R25; all 1 k ohm.
12) Install R7, R15, R16 and R17: all 270 ohm.
13) Install R8; 150 ohm, Read color coding carefully.
14) Install R18 and R28; both 100 ohms.
15) Install Q1; MRF502, Q2; 2N5484, Q3 and Q4; 2N5771, Q5; 7545 and Q6; 7546. Note the positioning of these transistors before installing. Keep the leads of Q4 and Q1 short so that the total height of each part does not exceed 3/8".
16) Install VR-1; 7805 voltage regulator. Bolt the regulator to PC board before soldering using (1) 4-40 x ¼" screw and nut.
17) Install C15; 1000 ufd and C16; 220 ufd. Be sure both parts are seated against PC board. Note polarity.
18) If you are going to use the standard 1 ppm time base follow steps 19 thru 21. If you are going to use the micro power 0.1 ppm oven proceed directly to step 22. Be sure to read all instructions given with the micro power oven.
19) Install C14 and C17. These part values are matched to the crystal used and may vary. See parts list.
20) Install R19; 22 meg ohms and C13; trimmer capacitor.
21) Install Y1; 10.000 mhz crystal. Note: When using the standard 1.0 ppm crystal time base, diode CR7 is not used. Proceed now to step 24, ignore steps 22and 23.
22) Install the precision oven oscillator module as shown in diagram. Be sure the module is aligned properly and seated firmly against PC board. Note that there are no parts installed or supplied for R19, C13, C14, C17 or Y1.
23) Install CR7 as shown. Note, CR7 is used ONLY with oven option!
24) Install U1; 11C90, U2; 74196, U3; 7216 and U4; 10116 IC's. Be sure that the IC's are installed in the correct sockets and that they are not installed backwards. Are all the IC leads inserted

34) Note the location of the battery holder mounting holes and position the battery holder over VR-1 so that the red and black leads face toward the front of the counter (toward readout board). Note which holes in PC board line up with mounting holes in battery holder.

35) Install the two 3/8" standoffs on the componet side of the PC board in the holes that line up with the battery holder. Use two 4-40 x 3/16" screws. Posistion standoffs so they don't short.

36) Mount the battery holder to the top of the standoffs using two 4-40 x 3/16" screws. Be sure not to damage any parts under the battery holder. The two conductor cable from the 'AC' holes should extend out to the rear.

37) Locate the bottom housing. (the half with the two holes)

38) Locate the four rubber feet, peel off the protective paper and mount them in the four corners of the outside bottom cover.

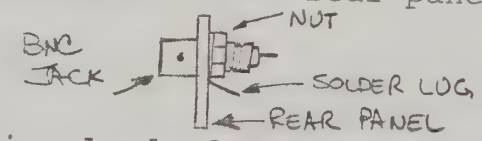
39) Slide the front panel into the groves provided on the bottom housing.

40) Place the main PC board into the bottom housing so that the three slide switches extend thru the switch holes in the front plate.

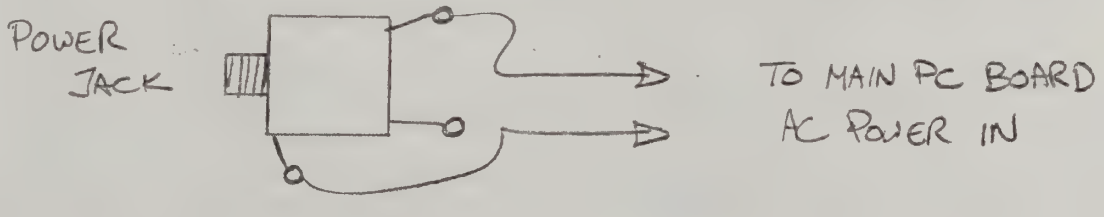
41) Mount the PC board using the four 4-40 screws. Do not overtighten.

42) Locate the rear panel and mount the miniature phono jack to the center hole.

43) Mount the two BNC connectors to the rear panel. Install a solder lug under each nut.



44) Solder the two remaining leads from the cable connected to the 'AC' holes to the phono jack as shown:



45) Slide the rear panel into the rear slots of the bottom housing.

46) Locate C1; .01, connect one lead to the center of J1 and the other lead to the PC land that connects C2, CR1, and CR2. Keep the leads as short as possible. You may wish to remove the battery holder while doing this.

47) Using a scrap component lead, connect the ground lug of J1 to the ground plane of the PC board. Keep this lead a short as possible.

48) Connect a scrap component lead from the center of J2 to the pad on the main PC board labeled J2. Keep this lead as short as possible.

49) Connect a scrap component lead from the solder lug of J2 to the PC board ground plane. Keep this lead as short as possible.

Its input can come from the UHF section (U4) or the VHF section (Q4). If the 10 mhz mode has been selected U2 is bypassed completely and the signal is sent directly to U3, the counter IC.

The timebase for U3 can be supplied by Y1 and its associated components or by an external timebase. The counter IC will use whichever timebase that has been selected at pin 1. If CR7 is installed, the timebase connected to pin 24 will be used. The counter IC generates all its own housekeeping functions such as multiplex, strobe, gate and reset signals. A logic circuit inside the counter IC senses the scanned readout signals (D0 thru D7) and also the input to pin 14, the gate select input. By comparing these inputs, the counter IC generates the selected gate time. The decimal point is displayed the same way. A logic circuit inside the IC looks at the scanned outputs D0 thru D7 and compares this with the signals selected by S2.

The power supply uses a simple bridge rectifier circuit that will accept an AC or DC input. Regulator VR1 provides a stable 5V power source while R28 and CR12 provide the charging current for the nicads (if used). Capacitors C15 and C16 provided added filtering.

Trouble Shooting Hints: The first step involved in trouble shooting is to carefully examine all your work. Check parts placement against parts list and PC layout. Make sure all diodes, transistors, IC's and capacitors are orientated correctly. Above all, check all solder connections! Examine all PC runs to verify that no solder bridges exist. Carefully check the readout board as it has quite a few close foil runs.

PROBLEM: Entire display does not light;
Check: Power supply voltages, connections to readout board, solder bridges across power switch and correct external supply (if used). Also check the timebase circuit used. If the counter lacks a timebase input the display may blank.

PROBLEM: 5V not present
Check: CR8 thru CR14, VR-1 and battery holder assembly. Check for shorts on the 5V buss. Are any IC's inserted backwards?

PROBLEM: Display lights but shows odd characters
Check: All solder joints on readout board- Look closely for bridges.

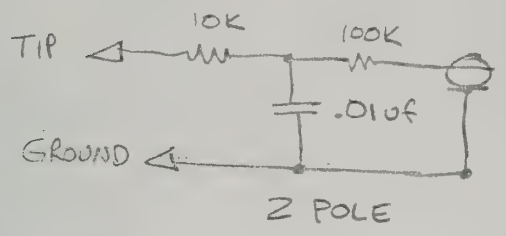
PROBLEM: Digit not lit
Check: U3, be sure all pins are seated properly. Check PC traces connecting pins 1 and 6 of readout.

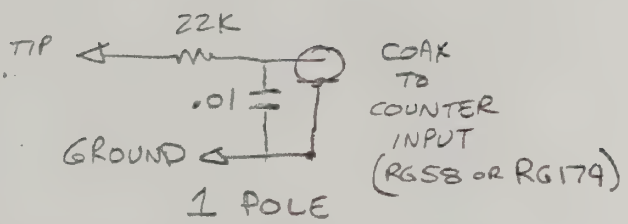
PROBLEM: Segment not lit in all digits
Check: U3, Be sure all pins are seated properly. Check PC traces to readouts for shorts and open connections.

PROBLEM: Only one digit lit.
Check: Timebase circuits, connections to pins 1 and 6 of lit readout. Also look at power supply voltages.

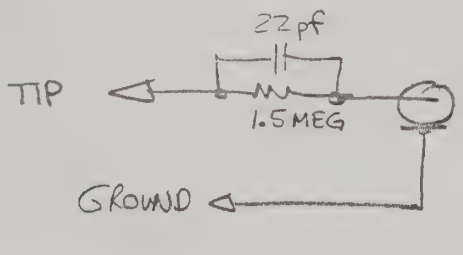
PROBLEM: Display flickering.
Check: Power supply voltages. Note that when unit is used for extended periods from AC adapter, some power is used from batteries (nicads only). A full charge can only be provided when the power switch is in the off position.

LOW PASS PROBES:





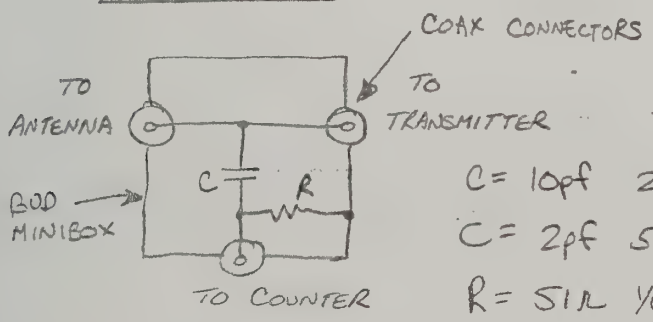
For General Usage (20 khz to 60 mhz) Measurement: The majority of signal measurements are usually within this range. Ringing and noise are the chief culprits in measurement. The only way to counteract these undesirables is to damp the ringing and/ or attenuate the noise (with the signal too, unfortunately). A simple X10 oscilloscope probe works well to attenuate noise as well as providing a less loading probe. If the noise is at a 10 mv level and signal at 1 volt, the X10 probe will reduce the noise to 1 mv and the signal to 100 mv, thus the noise is out of the counter's sensitivity range, while the desired signal isn't. The X10 probe or high impedance probe will also generally damp out ringing. Another benefit of the high impedance probe is that it doesn't load the circuit being measured by the input cable's capacitance. This is especially important when measuring oscillators or amplifiers. A simple high impedance probe is shown below:



Atten ≈ x3
LOADING ≈ 15pf
FLATNESS ≈ 3db to 30 MHz

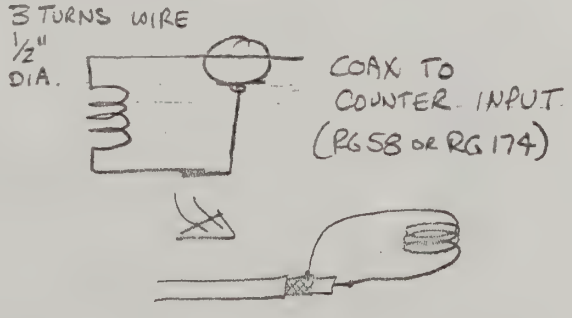
For Direct Transmitter Measurement: Measuring a transmitter requires coupling enough transmitter energy into the counter for a stable count and not so much as to exceed the counter's safe input. Generally, for VHF work, a small 18" whip antenna will pick up a transmitter from 5 to 10 feet away. Direct connection to the transmitter can be made via a coupling box or pick up loop. The pick up loop is simply a few turns of wire wrapped around the transmitter's antenna coax and fed to the counter. The coupling box requires breaking into the transmitter's antenna coax. Schematic is shown below:

COUPLING BOX



C = 10pf 2-50mhz
C = 2pf 50-500 mhz
R = 51Ω 1/4w

SNIFFER LOOP

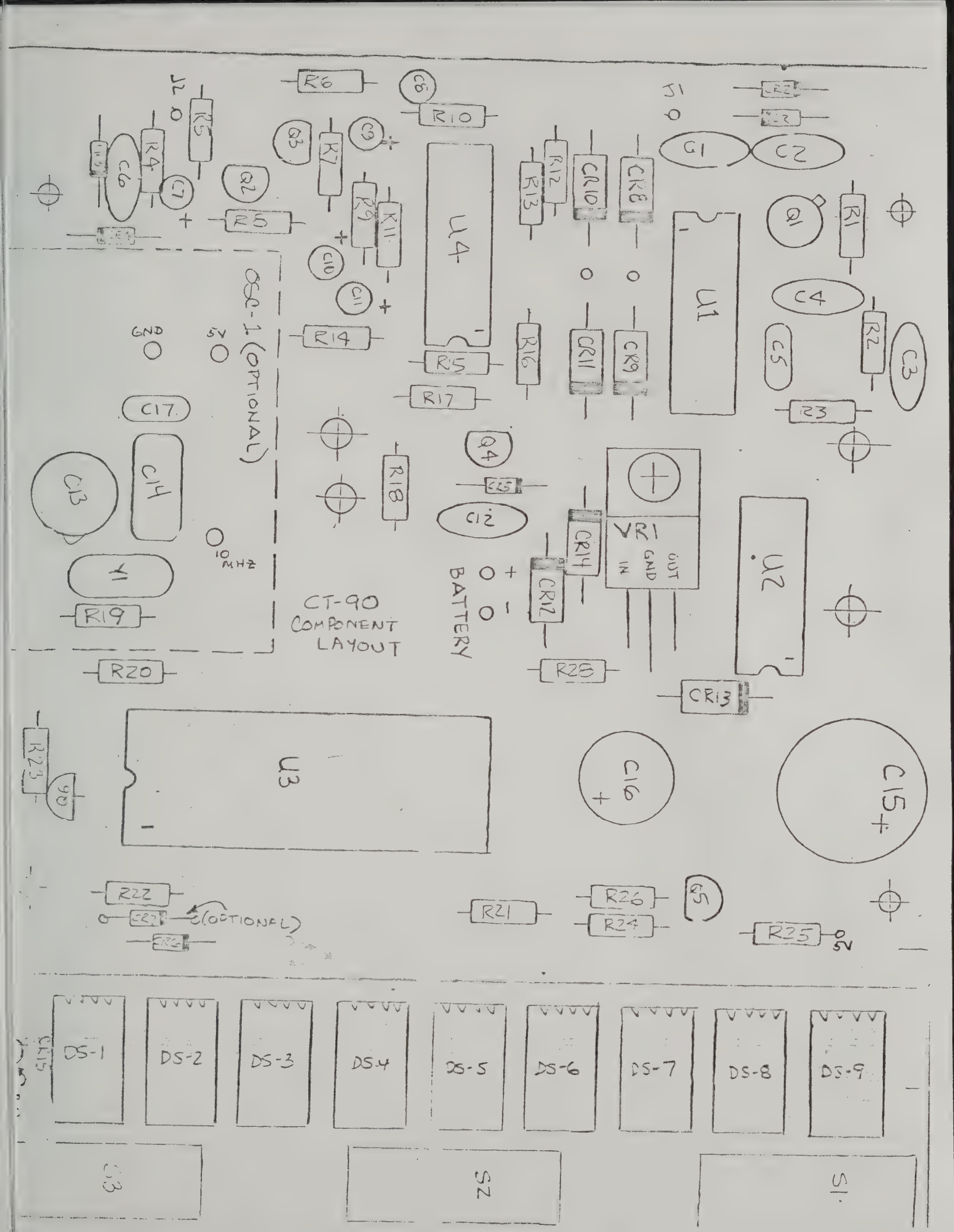


CT-90 PARTS LIST

DESIGNATOR	DESCRIPTION	PRICE (each)
C1 thru C5, C12	.01 uf disc	$ .15
C6	100 pf disc	.15
C7 thru C11	1 to 10 uf	.40
C13	4-40 pf (used in std TB)	.65
C14, C17	22 pf	.25
C15	1000 uf, 16VDC	.95
C16	100 uf, 16VDC	.45
C18	22 pf disc	.25
CR1 thru CR6	1N4148type, small signal diode	.15
CR7	1N4148type, (optional Time base)	.15
CR8 thru CR14	1N4003type,1 amp power diode	.15
CR15	LED, Mini-red	.20
DS1 thru DS9	FND 359,357 Readout	1.75
J1, J2	BNC connector	1.90
J3	Sub miniature phono jack	.60
Q1	MRF502, NPN transistor,2N5179	1.25
Q2	2N5484, FET	1.00
Q3, Q4	2N5771, PNP transistor,2N4258	1.00
Q5	NPN, 7545; 2N3904 type,0139	.35
Q6	PNP, 7546; 2N3906 type,2106,7012	.35
R1,R20-R24, R26	10 k ohms,Brn-Blk-Org	.10
R2,R10,R12, R13, R14	470 ohms, Yel-Vio-Brn	.10
R3	Jumper Wire	---
R4	100 k ohms, Brn-Blk- Yel	.10
R5	1 Meg ohms, Brn-Blk-Grn	.10
R6, R9, R11, R25	1 K ohms, Brn-Blk-Red	.10
R7, R15, R16, R17,	270 ohms, Red-Vio-Brn	.10
R8	150 ohms, Brn-Grn-Brn	.10
R18, R28	100 ohms, Brn-Blk-Brn	.10
R19	22 meg ohms, Red-Red-Blue (STD OSC only)	.10
R27	15 ohms, Brn-Grn-Blk	.10
S1, S2, S3	Slide switch, 3 position	2.15
U1	11c90, High speed decade prescaler IC,8680	13.50
U2	74196, TTL decade counter	1.50
U3	7216, MOS, LSI counter	21.95
U4	10116, ECL Amplifier	1.25
VR-1	7805, voltage regulator, 5V	1.00
Y1	10.0000 Mhz crystal	6.00

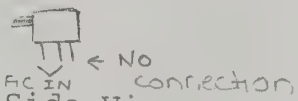
Non- Referenced Items

Socket Set 1-28 pin, 2-16 pin, 1-14 pin	2.15
CT-90 PC board	20.00
CT-90 Display board	8.00
Hook-up wire, 4"- 2 conductor	.15
Phillips head screws, 1", Qty 2	.30
Solder Lug, 3/8" hole size, Qty 2	.10
Rubber feet, strip of four, pressure sensitive	.50
Red lens, 4½" x 3/4"	.50


CT-90
COMPONENT
LAYOUT
OSC-1 (OPTIONAL)
GND
5V
10 MHz
BATTERY
VR1
GND
OUT
IN
U1
U2
U3
U4
DS-1
DS-2
DS-3
DS-4
DS-5
DS-6
DS-7
DS-8
DS-9
S3
S2
S1
(OPTIONAL)

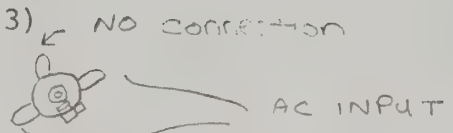
CT-90 REVISIONS

1. Enclosed phono jack may look like:



Side View

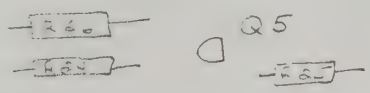
— or —



AC Input Rear View

2. Be sure stand-offs (step 35) do not short 5 volt trace to ground.

3. Q5 is drawn backwards on layout. Should be:



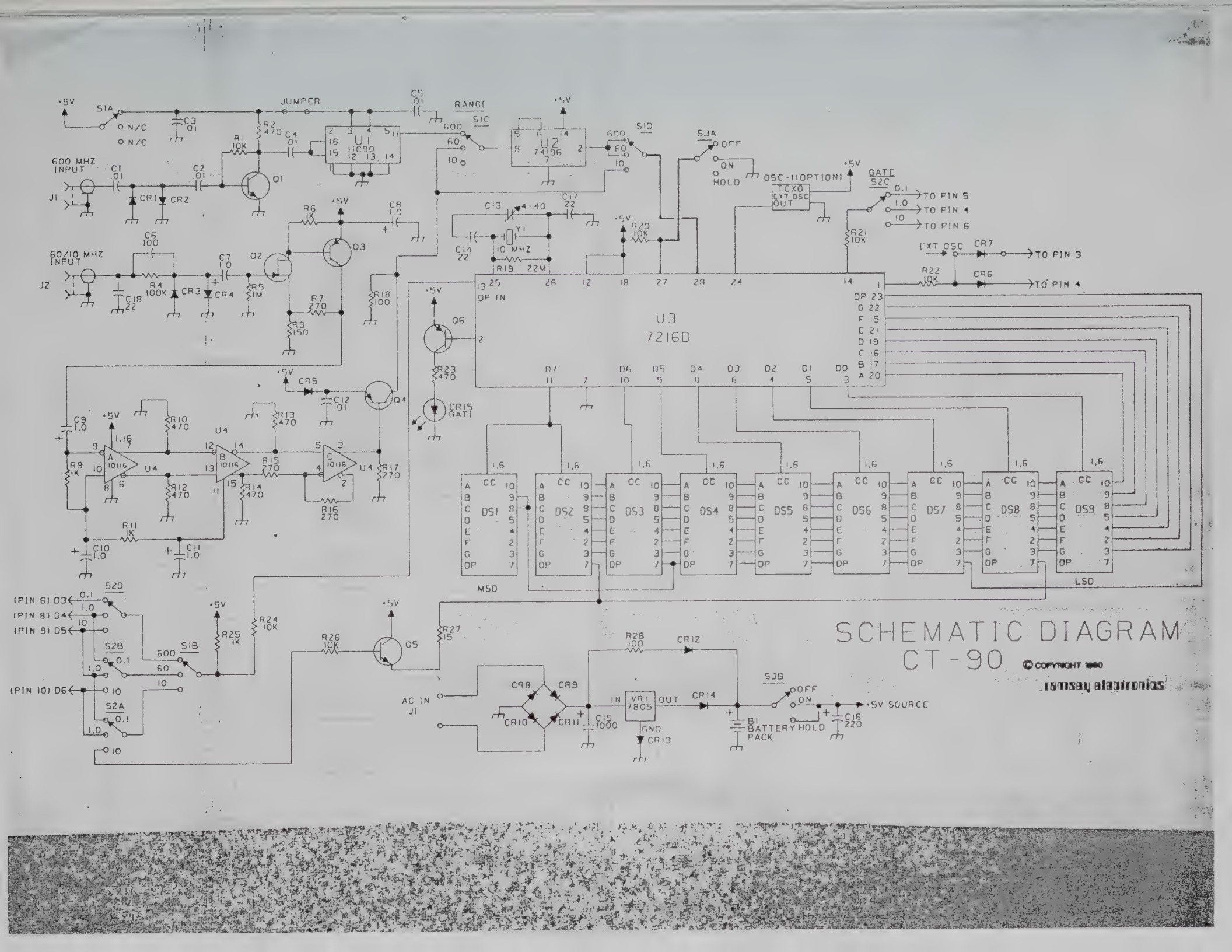
4. R23 is 470 ohms.

5. In step 34, red and black leads may not face forward.

6. C14, C17 may be 47 pf.

7. C12 changed from .01 to 10 uf.

8. CR-5 changed from IN914 to IN4003.


SCHEMATIC DIAGRAM
CT-90
© COPYRIGHT 1980
ramsey electronics
U3
7216D
U1
MC90
U2
74196
600 MHZ INPUT
60/10 MHZ INPUT
JUMPER
RANGE
OSC-(OPTION)
TCXO
EXT OSC
OUT
GATE
TO PIN 5
TO PIN 4
TO PIN 6
TO PIN 3
TO PIN 4
DP IN
MSD
LSD
(PIN 6) D3
(PIN 8) D4
(PIN 9) D5
(PIN 10) D6
AC IN
J1
VR1
7805
GND
BATTERY PACK
HOLD
+5V SOURCE

Ramsey Electronics CT-50 Frequency Counter

Introduction: The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 mhz and up to 600 mhz with the optional prescaler. Large Scale Integration, CMOS circuitry and solid state display technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation.

Specifications:

Sensitivity: less than 25mv, typically 10mv
Frequency range: 5Hz to 60mHz, typically 65mHz
Gate time: 1.0 seconds 1Hz resolution, 0.1 seconds 10Hz resolution
Decimal points: automatic in all modes, including prescale
Display: 8 digit red LED 0.4 inch height
Stability: 2.ppm over 10° to 40°C Temp comp.
Accuracy: Adjustable to .5ppm.
Input: BNC, 1 megohm direct, 50 ohms on prescale (optional)
Overload: 50 VAC, all modes
Power: 110VAC, 5W or 12VDC, 400ma.
Size: Approx. 6"x4"x2", high quality aluminum case

Optional CB-1 Burst adapter:

Accuracy: less than 0.001ppm
Input Impedance: greater than 1 meg, 10 pf
Power: 12VDC, 30Ma from CT-50 power supply

Optional CT-600 Prescaler option:

Sensitivity: less than 100mv to 500mHz, 150mv to 600mHz, typically 10 - 25mv at 150Hz
Overload: 2 watts, diode limited, resistor fuse protected
Input impedance: 50 ohms nominal
Frequency: 25mHz to over 600mHz, typically 650mHz

Construction notes: Use a small tipped iron for assembly. A power rating of 30-50 watts is ideal. Do not use a soldering gun! Do not use any sort of additional solder flux, use only a good grade of rosin core solder. Proper soldering techniques are important! Each joint should be shiny and completly surround the lead wire. There should not be just a slight dab of solder barely held on to the lead. Don't be afraid of damaging a component due to too much heat, modern day semiconductor can withstand more heat than your iron can put out! Use enough heat to form a good solid joint, a quick touch of the iron is usually not enough. The main PC board has plated thru holes, thereby eliminating the need to solder top side of the board. This, however, makes removing a part more difficult, so follow the directions closely.

Note that all parts stand upright on end. Do not mount the parts flat, to do so may cause unnecessary shorts between component leads. Keep component lead lengths as short as possible.

Assembly: Unpack all parts and check against parts list for errors, notify Ramsey Electronics immediately of any discrepancy. Review all details in the instruction manual. Save scrap resistor leads as they will be used later for jumper leads. Check off each step as you go along.

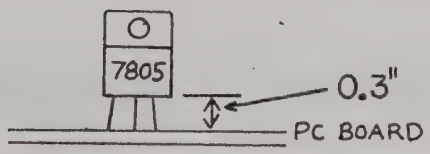
1) Install 16 pin IC socket at U11 location and insert U11, 10116. When installing ICs, pay close attention to posistion of notch or pin 1 locator.
2) Install 14 pin socket at U10 location and install U10, 74S00
3) Install 16 pin socket at U8 location and insert U8, 4049
4) Install 14 pin socket at U5 location and insert U5, 74196
5) Install 14 pin socket at U12 location and insert U12, 4013
6) Install 14 pin socket at U9 location and insert U9, 4011
7) Install 16 pin socket at U14 location and insert U14, 4518
8) Install 8 pin socket at U13 location and insert U13, 5369
9) Install 14 pin socket at U6 location and insert U6, 7490

10) Install 16 pin socket at U4 location and insert U4, 4511
11) Install 16 pin socket at U3 location and insert U3, 4511
12) Install 14 pin socket at U7 location and insert U7, ITT-500
13) Install 28 pin socket at U2 location and insert U2, MK-50398
14) Install R50, 15 ohm; R29, 470 ohm and R1, 270 ohm. All located near U1
15) Install CR10, 1N4148 type diode, observe cathode band
16) Install R28, 110 ohm
17) Install Q4, 2N5771, observe posistion of flat side
18) Install C2, 10uf and C21, .01uf. Observe C2 polarity.
19) Install R32, R31, R34, R33, all 470 ohm
20) Install R36, 1K and R39, 150 ohm
21) Install R38, 270 ohm
22) Install Q6, 2N5485 and Q5, 2N5771. Observe flat side posistion.
23) Install C12, 10uf and C11, .22 to .68uf tantalum, observe polarity
24) Install R37, 1K and R30, 180 ohm
25) Install C10, .01uf
26) Install C15, 10uf, observe polarity
27) Install R40, 1Meg and CR11, CR12, 1N4148 type diodes, observe cathode bar
28) Install R42, 100K and C16, 100pf
29) Install C14, 4.7 to 10uf tantalum, observe polarity
30) Install C13, .01uf, R35, 51 ohm and R41, 1K ohm
31) Install R18, 100K, CR6 and CR7, 1N4148 type diodes, observe cathode band
32) Install wire jumper in place of CR-19

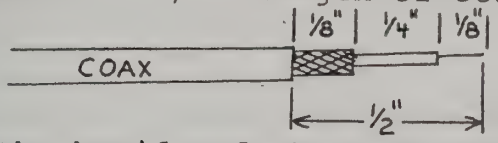
NOTE: R47,R46,CR17,18,C17,R44,R45,C18,U15,C20,R43,C19,Q7 and Q8 are part of the CT-600 option and are not included in the basic CT-50 kit.

33) Install trimmer capacitor, C9 and R25, 22Meg
34) Install C7 and C8, selected capacitors, 10 to 47pf range
35) Install Y1 crystal. Mount it slightly above the PC board (1/16")
36) Install R48, 100K and CR8, 1N4148 type diode, observe cathode band
37) Install R23, 10K and Q3, NPN, observe flat side placement
38) Install CR9, 1N4148 type diode and R24, 10K. Observe cathode band
39) Install R22, 100K; C4, .001; and Q2, NPN, observe flat side
40) Install R16, 10K; C3, .001; R17, 10K; R15, 1K and Q1, NPN; R14, 10K
41) Install C5, .001uf and R21, 100K
42) Install C6, 100pf and R20, 1Meg
43) Install R49, 1K and R19, 10K
44) Install R27, 270 ohm and R26, 470 ohm
45) Install R4, 51 ohm; CR3, CR4, 1N4148 type diodes, observe cathode band
46) Install R2, 51 ohm; CR2, CR5, 1N4148 type diodes, observe cathode band
47) Install R3, 51 ohm
48) Install C1, 1000 uf; CR13-CR16 1N4001 type diodes. Observe cathode band.
49) Install CR1, 1N4001 type diode, observe cathode band
50) Locate piece of thin green enamled fuse wire. Cut a 1/2" piece and form into a small loop. Slip a 1/4" long piece of spaghetti tubing over the loop and solder to the holes marked 'F1' above S3.
51) Prepare a 3 1/2" piece of coax as follows: Strip each end back 3/4", separate braid from center conductor and tin, strip center back 1/8" and tin. Locate isolated input hole between S1 and S3 labled 'IN'. Solder center conductor to this hole and braid to ground plane around hole. This piece solders on component side.
52) Install S1, S2, S3 switches, make sure switches are seated properly
53) Install jumper wires. There are a total of three; one above U5, 1 1/2" long; one below U3, 2" long, and one above R3, 3 1/2" long. The jumpers are cut from the insulated wire supplied.
54) Insert a scrap component lead into the TP-1 hole near U13. Solder and trim the lead so that about 1/2" sticks up from the component side of the PC board.
55) Install U1, 7805 regulator. It should mount about 0.3" above the PC board. Note that the metal tab faces to the back of the board (towards chassis).

55) Continued...

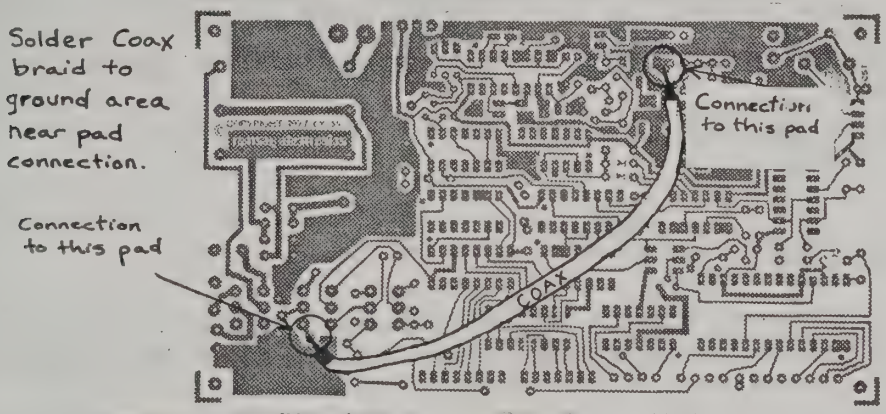


56) Prepare a 5 1/2" length of coax cable. Strip each end as follows:



Be careful when stripping the center conductor so that you don't pull the entire center out from the cable. Hold the cable tightly when stripping.

Tin the braid and the center conductor. When tinning the braid, use enough heat to tin it fully- do not use too much however, this will melt the center insulation and cause a short. When done, solder the piece of coax on the solder side of the board as shown below.



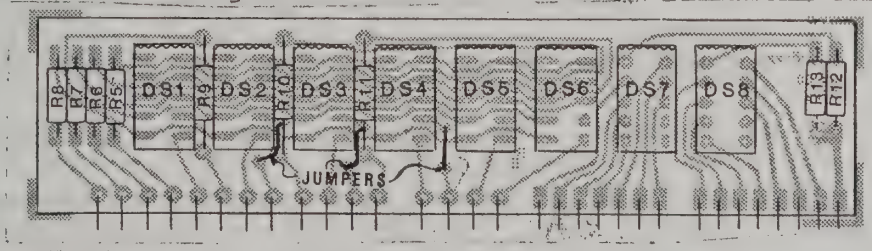
The coax pads are also indicated on the top side printed component layout

57) Install transformer T1, note carefully the posistion of the dot on T1 and the PC board. The dots MUST be posistioned correctly for proper operation The dot on the transformer is located on the label.

58) Locate C22, .01 uf. Install it on the solder lugs on switch, S2, see page 11 for details. Keep leads fairly short.

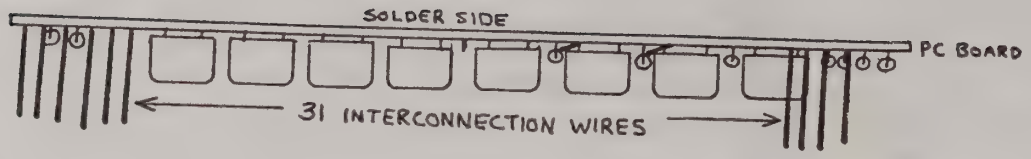
Readout Board assembly: The readout board has many fine PC traces and require much care in assembly, inspect each joint after soldering for any possible bridges. It is much eaiser to find mistakes now, as trouble shooting solder bridges is quite difficult. Do not rush this portion of assembly!

1) Install jumper wires under the R10, R11 locations using scrap component lead wire. Use a 1/4" long piece of spaghetti tubing on each jumper. Press the jumpers close against the PC board. Install third jumper near DS4.

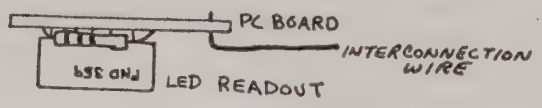


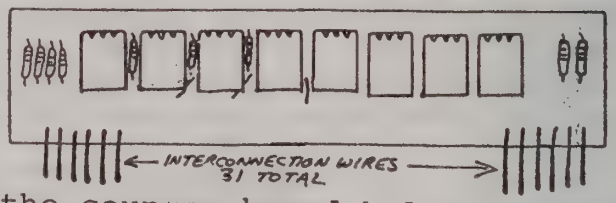
locations of the 3 jumper wires:
one under R10 location
one under R11 location
one between DS4, DS5
Be sure jumper wires are not touching resistor leads.

2) Install R5 thru R11, all 270 ohm
3) Install R12 and R13, 82 ohm
4) Place DS1 thru DS8, LED readouts in PC board. Note posistion of notches on tops of readouts. Turn the board over with the readouts sitting flat upon a flat surface. Push down on the PC board firmly to line up all readouts evenly, then solder.
5) Check alignment of readouts and if any are not posistioned evenly, repair.
6) From scrap component lead wire, install the 31 inter-board jumpers as follows: Set the readout board down flat on the readouts with the solder side up. Insert a lead wire at least 3/4" long into the two end holes. Solder the two leads so that 1/2" extends from the component side of the board. With the board still standing solder side up, propped up by the two end leads, insert and solder the remaining 29 wires. See diagram.

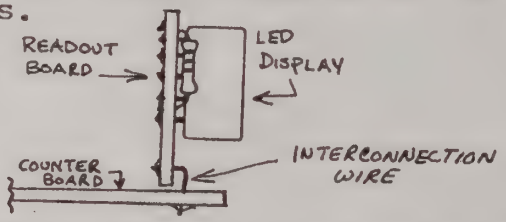


7) Bend each lead sharply so all extend away from PC board.





8) Line up the readout board wires with the counter board holes. Insert and solder all leads.



9) Once more, carefully inspect the boards for any solder bridges, unsoldered joints or cold-solder joints. A good visual check now will save hours of trouble shooting time later.

Case Assembly:

1) Carefully unwrap the chassis section and locate the press on rubber feet. Apply the feet to the chassis bottom. Do not place the feet within 1/4" of the corner holes (leave room for the screws).
2) Locate the two brass elbow brackets, two long 4-40 screws and two 4-40 nuts. Install the brackets in the center holes on each side of the case.

3) Locate the threaded standoffs. Install them in the four corner holes of the case using short 4-40 screws.
4) Locate the 3/8" press in grommet and insert it into the large hole in the back of the chassis.
5) Locate the BNC connector and solder lug. Insert the connector into the panel and secure with solder lug, washer and nut.
6) Locate the line cord and pull about 6" thru the rear panel grommet. Strip each end about 1/4" and solder to the '110 VAC IN' holes on the counter board. Use care making sure that any fray strands of the cord are cut and do not touch anything.
7) Press in all the pushbuttons on the counter assembly and slip the unit into the case. Feed the line cord out the grommet as the board is being slid in
8) When the board is seated, install the 4 corner mounting screws.
9) Bolt the 7805 regulator to the case using long 4-40 screw and nut.
10) Bend the BNC connector's solder lug out and solder the input coax shield to it. Solder the center conductor to the BNC center pin.
11) Locate the plastic pushbutton covers. Press the red one over the power switch and the remaining ones over the other switches. Press firmly until the cap snaps on, but don't force it after it is seated.
12) Locate the piece of red filter. Carefully remove the backing paper and slide the filter behind the window in the case. Tension between the case

Step 12 continued...
and readouts will hold it in place.
13) This completes the case assembly.

Checkout:
1) Connect a voltmeter between the case and pin 14 of U10, 74S00 Pin 14 is on the corner above R49.
2) Turn the power on, verify a voltage of 4.5 to 5.5 VDC. If not correct, turn off power and consult Trouble Shooting Hints.
3) Remove the voltmeter and leave the power on. Within a few seconds all displays should light up.
4) Cut an 8" piece of wire and strip each end back 1/8" and tin. Temporarily solder one end to the center pin of the BNC connector. Touch the other end to TP1, located near U13. With the 'GATE' and 'SCALER' buttons both out, the counter should display the approximate frequency of 3.579540mHz. Depressing the 'GATE' button should move the entire display to the right one digit.
5) If all checks out, remove the wire and discard.

Calibration:
1) Set the top cover on the CT-50 and allow it to warm up for at least 30 minutes.

Methode A:
1) Connect a signal of known accuracy (a 100kHz calibrator which has just been zero beated to WWV works well) to the counter input. Set the gate time to 1.0 seconds and adjust C9 until the display shows the proper frequency.

Methode B:
1) Using a counter of known accuracy, measure the frequency at TP-1 using a high impedance probe. Adjust C9 for a frequency of 3.579540mHz.
2) When calibration is completed, fasten the case cover on to the chassis using 4-40 screws. The assembly of the CT-50 is now complete.

Options

12VDC option: The CT-50 will accept 12 to 15VDC as a power source. To run the CT-50 on DC, route a cable thru the 1/4" option hole in the rear of the chassis to the 12VDC input holes located near S3. Note the lables on the holes, 'GND' and '+12 IN'. Solder the cable to the indicated holes in the PC board. If desired, a jack could be installed in the option hole.

CB-1 option: The CT-50 time base may be locked to an external frequency standard. The television networks maintain extremely accurate atomic based frequency standards to maintain color tint on TV programs. These standards are typically accurate to one part in 10 to the 12. By locking the CT-50 to one of these network standards, we are able to get super accuracy. The CB-1 adapter interfaces a standard color TV receiver to the CT-50 so that one can take advantage of the TV network frequency standards. Complete data for this option is contained in the CB-1 kit.

CT-600 option: The CT-600 prescaler option enables the CT-50 counter to measure frequencies as high as 650mHz with sensitivity in the 30 to 150mv range, depending upon frequency. Typical sensitivity at 150mHz is 30mv. The CT-600 option mounts on the same board as the CT-50, no extra boxes or PC boards are required. The scaler utilizes a state-of-the-art Motorola ECL IC chip and individually selected components to insure high sensitivity. The scaler input is protected against overload and burnout by diodes and a resistor fuse. Complete data is contained in the CT-600 option kit.

Theory of operation:

Input signals arriving at J1 are routed thru S1 to either the input amp or prescaler. The input amp consists of a high input impedance buffer amp which drives an ECL amplifier/schmitt trigger. The ECL signal is converted to TTL by Q4 and passed on to selector gate U10. U10, which is also switched by S1 selects which output (from input amp or scaler) is gated into the counter section. The first part of the counter section is U5, a high speed decade counter. The carry output of U5 is counted by U6, another decade counter. The counter outputs are decoded and displayed by U4, U3 and DS8, DS7. The TTL level carry output from U6 is converted to 12 volt level by Q1 and fed to U2's count input. The six digit counter, U2, counts, latches, decodes and drives the remaining six digits. Pins 3 thru 9 drive the segment lines while pins 18 thru 23 enable the individual digits. U7 amplifies the digit enables so that the LEDs may be driven. These six digits are multiplexed, meaning that only one digit is lit at any one time. The eye, due to persistance of vision, sees a display that looks as though it is continuously lit.

Time base and gating circuitry is as follows: The crystal, Y1, is divided by 59,659 in U13 to get 60Hz. The first section of U14 divides by 6 producing 10Hz. The second section divides by 10, producing a 1.0Hz waveform. These signals are the standard gate times, 0.1 second and 1.0 second. Selection of either one of these gate times is controlled by part of U9, which is switched by S2. The outputs of these two gates are 'ORed' and fed to the gate flip flop, U12 which enables the count gate, U10. When U10 is enabled, a precise time controlled amount of pulses are counted by the counting section. After the time 'window' is up, a pulse is sent to parts of U8. U8 tells the counter section to display the count and then feeds another pulse to the second section of U9. This section of U9 inserts a slight time delay to make sure the count is displayed, then resets all of the counters to zero. The counter then waits until U12 enables the counting gate and the whole process repeats. Transistors Q2 and Q3 perform the same function as Q1 - changing TTL levels to 12 volt levels. Portions of U8 are simply buffers which produce the 'stiffer' drive required by the TTL counters.

The power supply is a standard full wave bridge which rectifies the AC from the transformer and produces approximately 12VDC. U1, a 5 volt regulator, derives a 5 volt source from the 12 volt supply.

The prescaler option accepts VHF and UHF signals, amplifies them by way of an IC on chip amplifier, divides by 10 and produces a TTL output signal. The TTL output is then routed to the selector gate U10.

Trouble Shooting Hints: The first step involved in trouble shooting is to carefully examine all your work. Check parts placement against parts list and PC layout. Make sure all diodes, transistors, ICs and capacitors are orientated correctly. Examine all IC pins to make sure they are seated properly. Above all, check solder connections! Examine all PC runs to verify that no solder bridges exist. Carefully check the readout board as it has quite a few close foil runs.

Problem: Entire display doesn't light. Check; power supply voltages, connections to readout board.

Problem; 5 volts not present. Check; placement of T1, orientation of CR13-CR16, c1, U1.

Problem; Only DS7, DS8 light or only one digit in DS1-DS6 comes on. Check; placement of U2 and U7, connections on C3

Problem; Only DS1-DS6 light. Check; placement of U3 and U4, leads on readout PC board.

Problem; Display lights, but shows odd characters. Check; all solder joints on readout board- look closely for bridges.

Problem; Digit not lit (DS1-DS6). Check solder connection around U7 and U2.

Trouble Shooting Hints continued...

Problem; Display appears to work, but won't count. Check to make sure signal is flowing thru counter. Follow signal thru input amp U11, gate U10 and up to counter input, pin 8 on U5.

Verify operation of time base. Check for 3.579540mHz signal at TP1, 60Hz at pin 1 on U13, 10Hz at pin 5 on U14 and 1.0Hz on pin 14 on U14. Make sure gate, strobe and reset pulses are being generate

Problem; Display of frequency is jittery. Signal being measured is either: varying in amplitude, varying in frequency or not large enough in amplitude to count.

Warranty

All parts used in the CT-50 counter are warranted to be free from any defects for a period of 90 days. Parts found to be defective within this period will be replaced promptly without charge upon receipt for inspection at the factory. After the warranty period has passed, parts may be purchased per the price list. Ramsey Electronics cannot be held responsible for faulty workmanship during assembly or damage/harm caused by construction or installation errors. Units obviously misused or modified are not covered by this warranty.

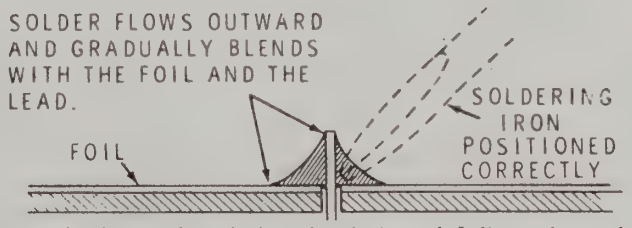
Repair Service

Assembled CT-50 kits may be returned for repair and calibration to factory standards for a fee of $20.00. This fee covers repair, calibration, shipping, insurance, handling and a service report on difficulties found. CT-50 units containing the CT-600 option may be subject to an additional charge.

Units assembled with paste flux, acid core solder or soldering guns will not be accepted. Ramsey Electronics reserves the right to refuse repair on unreasonably constructed units.

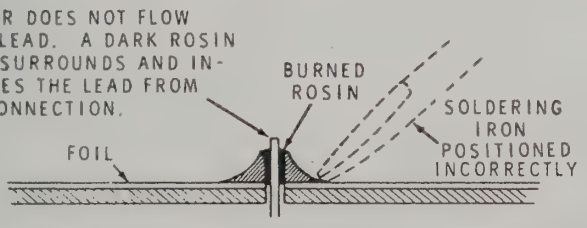
Pack all returns adequately and insure for your protection.

A GOOD SOLDER CONNECTION

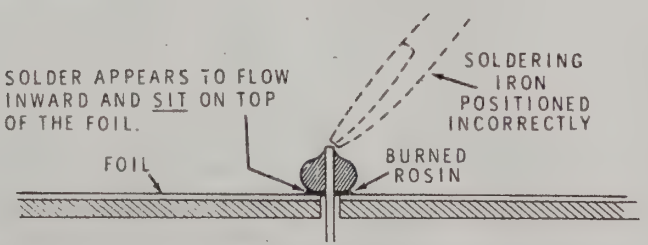


When both the lead and the circuit board foil are heated at the same time, the solder will flow onto the lead and the foil evenly. The solder will make a good electrical connection between the lead and the foil.

POOR SOLDER CONNECTIONS



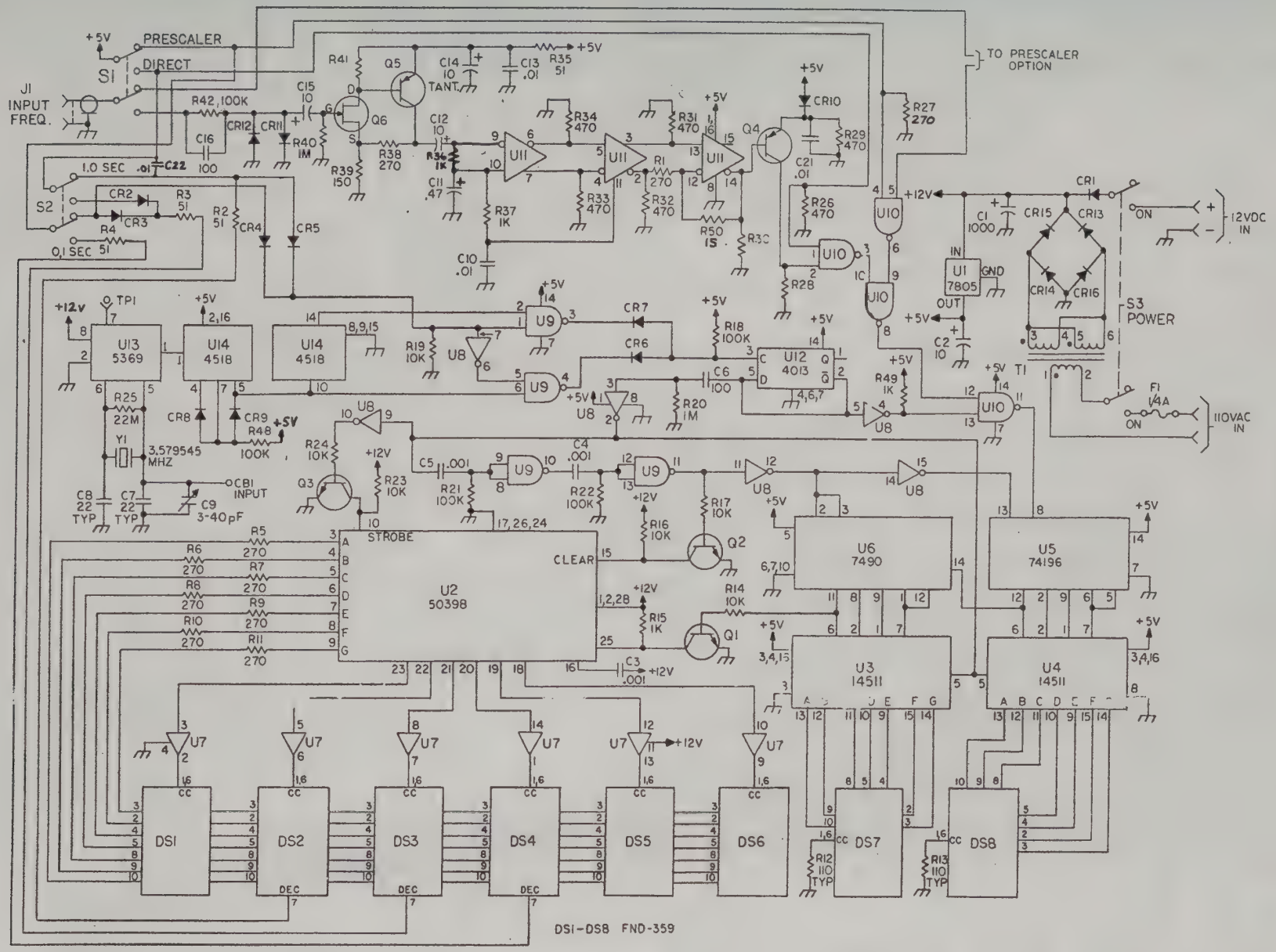
When the lead is not heated sufficiently, the solder will not flow onto the lead as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.



When the foil is not heated sufficiently the solder will blob on the circuit board as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

Parts List

Designator	Description	Price (ea.)
C1	1000uf electrolytic	.75
C2,C12,C15	10uf electrolytic	.25
C3,C4,C5	.001uf disc	.15
C6,C16	100pf disc	.15
C7,C8	10 to 47pf disc (selected)	.35
C9	3-40pf trimmer cap	.85
C10,C13,C21,C22	.01uf disc	.15
C11	.1 to 1.0uf tantalum	.45
C14	4.7uf dipped tantalum	.55
C17-C18	used in CT-600 option	---
CR1,CR13-16	1N4003 1 amp diode	.20
CR2-12	1N4148 type glass bead diode	.15
CR17,18	used in CT-600 option	---
DS1-8	FND-357,359 LED readout	1.00
Q1-3	NPN transistor, 237A (sim. to 2N3904)	.25
Q4,5	PNP transistor, 2N5771, or unmarked	1.00
Q6	2N5485,2N5484,MPF-102 FET	1.00
Q7,Q8	used in CT-600 option	
R1,5-11,38,41, 27	270 ohm 1/4 watt	.10
R2-4,35	51 ohm 1/4 watt	.10
R12,13	82 ohm 1/4 watt	.10
R14,16,17,19,23,24	10K ohm 1/4 watt	.10
R15,36,37,49,47	1K ohm 1/4 watt	.10
R18,21,22,42,48	100K ohm 1/4 watt	.10
R20,40	1Meg 1/4 watt	.25
R25	22Meg 1/4 watt	.25
R26,R29,R31-34	470 ohm 1/4 watt	.10
R28	110 ohm 1/4 watt	.10
R39	150 ohm 1/4 watt	.10
R43-47	used in CT-600 option	---
R50	15 ohm 1/4 watt	.10
R30	180 ohm 1/4 watt	.10
S1-3	DPDT pushbutton switches	.95
T1	PC-24-180 transformer	6.95
U1	7805 5V regulator	.95
U2	MK50398 MOS-LSI counter IC	12.50
U3,4	4511 or 14511 decoder-driver	2.50
U5	74196 TTL decade counter	1.50
U6	7490 TTL decade counter	.50
U7	500 LED digit driver	.75
U8	4049 CMOS buffer	.50
U9	4011 CMOS gate	.35
U10	74S00 TTL gate	.75
U11	10116 ECL amplifier	1.75
U12	4013 CMOS flip flop	.75
U13	5369 CMOS divider	1.95
U14	4518 CMOS divider	1.95
U15	used in CT-600 option	---
Y1	3.579545 crystal	3.00
Socket set	1-28pin, -14pin, -16pin	3.00



© COPYRIGHT 1977

SCHEMATIC DIAGRAM - FREQUENCY COUNTER

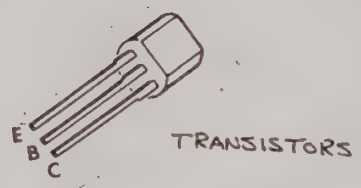
DRAWN J.R. 7/14/77 CHECKED J.W. D.W.

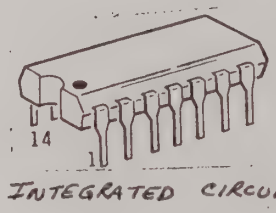
RAMSEY ELECTRONICS - ROCH., N.Y.

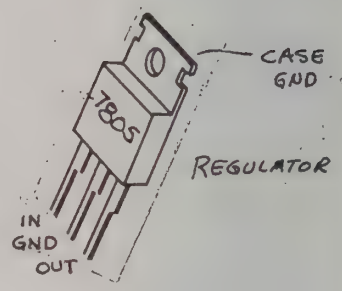
CT-50-1

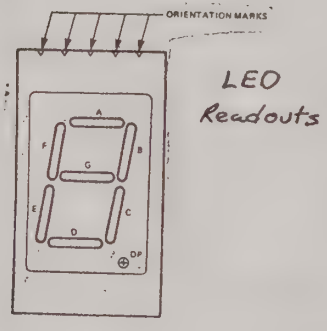
CT-50 counter PC board		15.00
CT-50 display PC board		4.50
Fuse wire	2"approx. 1/4 amp	.35
Hook up wire	6" length	.25
Coax cable	12" RG-174	.35
Spaghetti tubing	2"length	.25
Snap in grommet	3/8" hole size	.20
BNC connector	UG-625B/U	1.00
Solder lug	3/8" hole size	.10
Rubber feet	strip of four, pressure sensitive	.75
Red lens	1 1/2" x 4" x .062"	.95
4-40 screws	8- 3/16", 5- 1/4"	.50
4-40 nuts	3 pieces, 1/4" hex	.25
Standoffs(4)	4-40 threaded, 1/4" long	1.00
Brackets	Brass elbow, 2 pieces	.25
Case assembly, CT-50	CT-50 case, top and bottom	10.00
Line cord		1.00
Buttons	1-red, 2-black	.50

Parts Pinouts









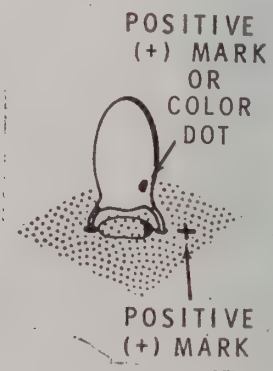
LEO Readouts

Pin Connections (See Bottom View)

Pin 1	Common Cathode	Pin 6	Common Cathode
Pin 2	Segment F	Pin 7	Decimal
Pin 3	Segment G	Pin 8	Segment C
Pin 4	Segment E	Pin 9	Segment B
Pin 5	Segment D	Pin 10	Segment A

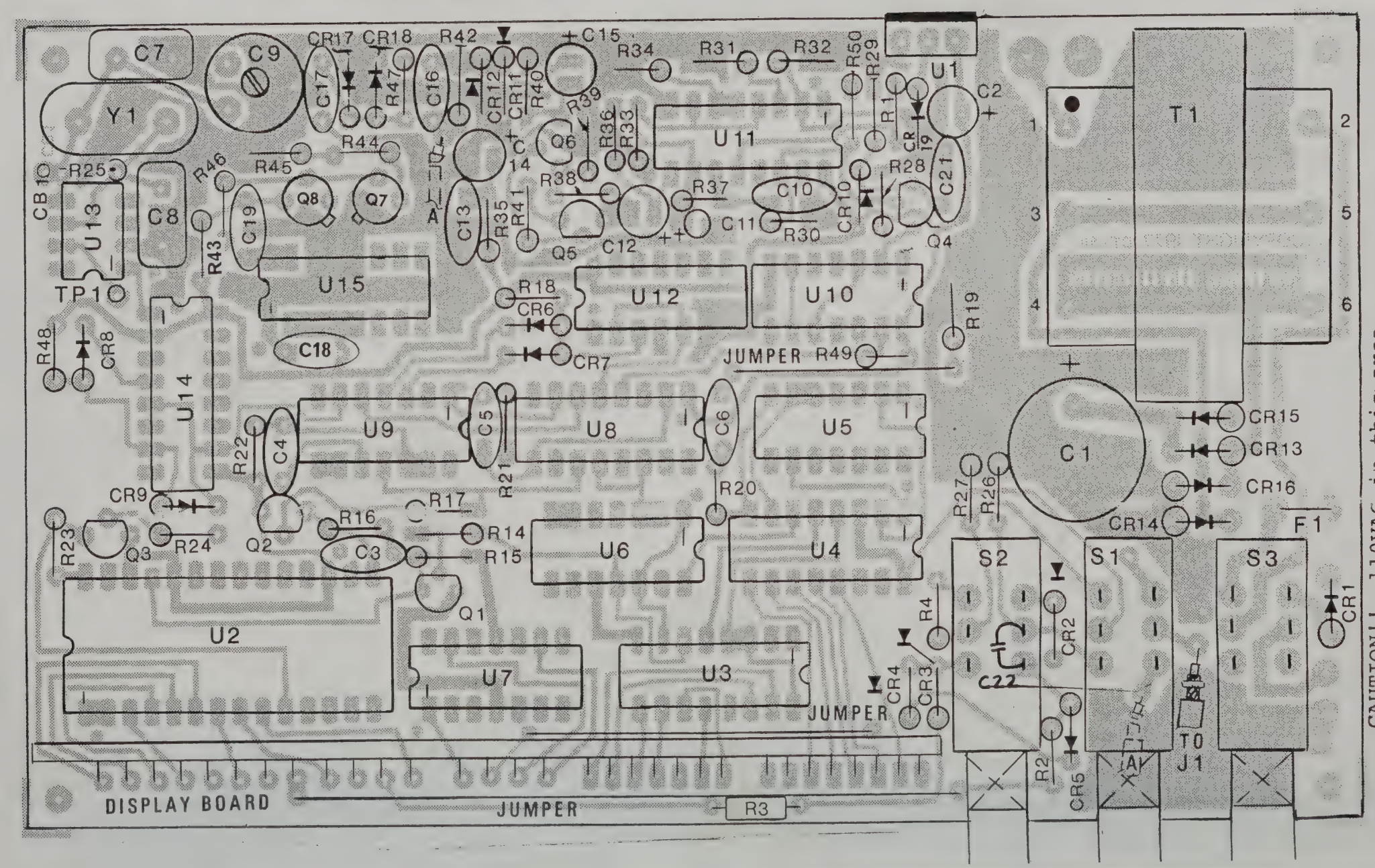
When you install electrolytic and tantalum capacitors be sure to match the positive (+) mark or color dot on the capacitor with the positive (+) mark on the circuit board as shown.

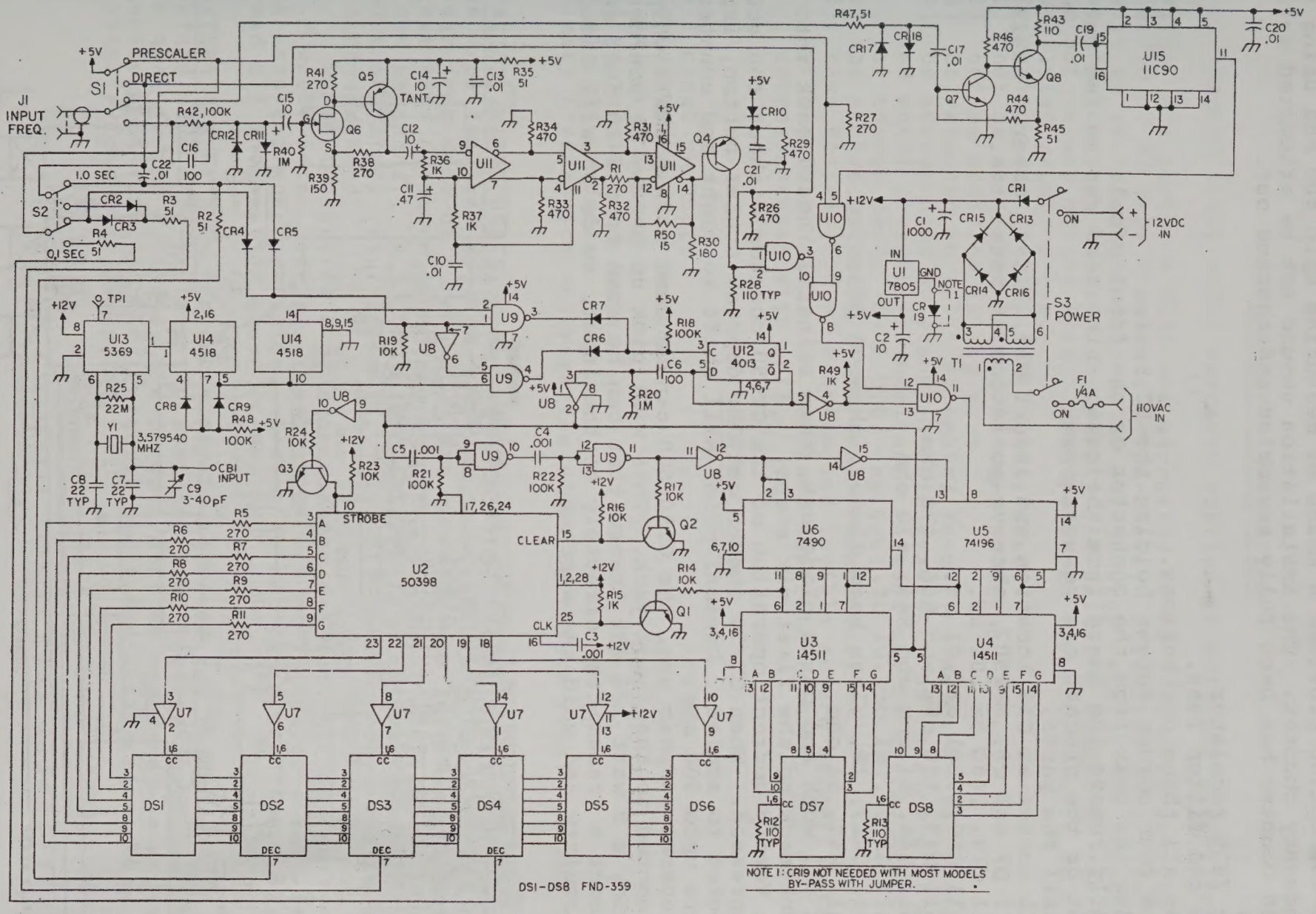
Tantalum Capacitors



Entire contents copyright 1977

Ramsey Electronics P.O. Box 4072 Rochester, N.Y. 14610 716-271-6487





SCHEMATIC DIAGRAM -
FREQUENCY COUNTER

RAMSEY ELECTRONICS - ROCH., N.Y.

COPYRIGHT 1977©

Assembly Instructions - CT-600 Option

The CT-600 option provides a means of measuring upto 600 mHz using the CT-50 frequency counter. The installation should not be attempted until your CT-50 counter has been fully assembled and checked out.

Assembly:

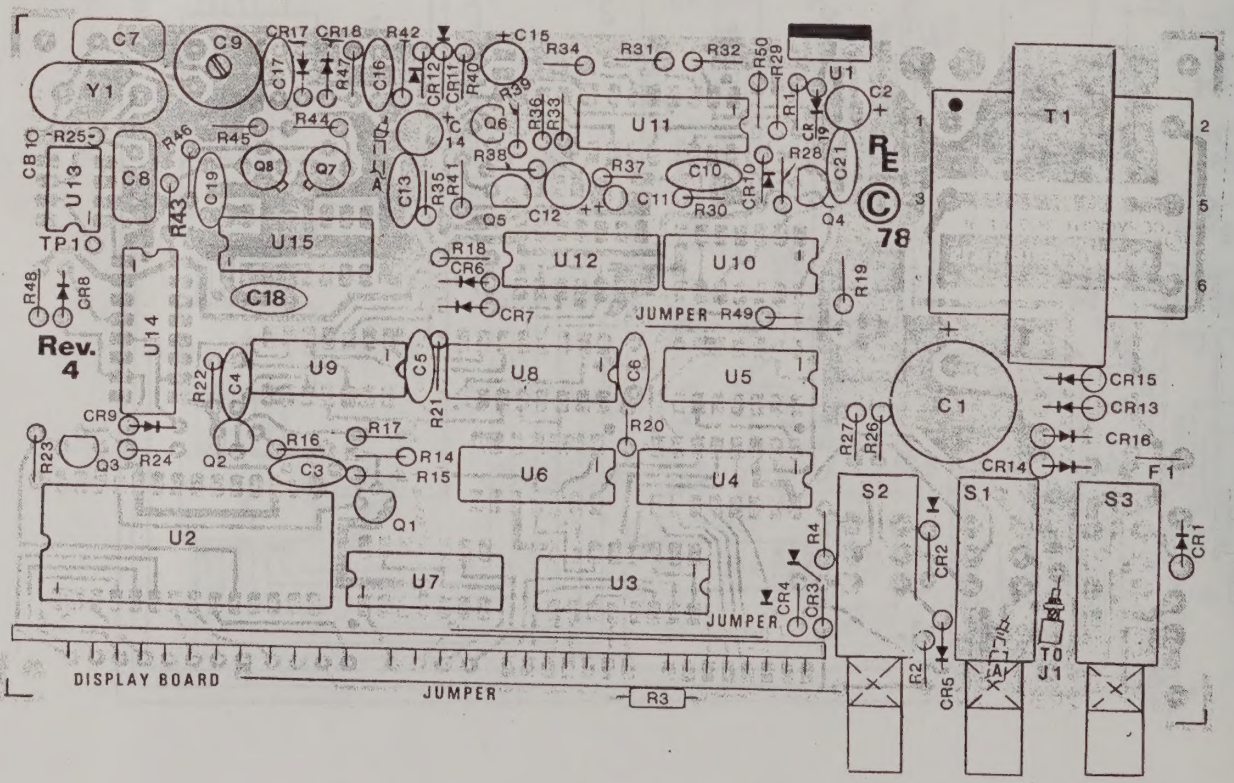
1) Unbolt 7805 regulator.
2) Remove red filter lens.
3) Depress all three pushbuttons.
4) Unscrew four corner screws holding the PC board.
5) Unsolder the coax from the connector on the front panel.
6) Carefully remove the board from the case. Line cord can be fed out the grommet or the grommet can be unsnapped.

Now, install the parts,

7) Install socket at U15 location and insert U15, 11C90, observe posistion.
8) Install Q7 and Q8, MRF502, observe posistion of metal tab.
9) Install C18, .001 or .01 uf.
10) Install C19, .001 or .01 uf.
11) Install R43, 110 ohm and R46, 470 ohm.
12) Install R45, 51 ohm and R44, 470 ohm.
13) Install C17, .001 or .01 uf.
14) Install CR17, 18, glass bead diodes, observe polarity.
15) Install R47, 51 ohm.
16) Check all work and parts placement, then reinstall board back into case by backtracking the first six steps.

Checkout: Verify correct operation of the CT-50 counter without the scaler button depressed. When CT-50 checks out OK, depress scaler button, input is now routed to scaler. Decimal point will shift to right and counter will now measure upto 600 mHz.

For general purpose use, the CT50/600 can be used with a small whip antenna connected to the input jack. This will pick up nearby RF sources. For example, a 2 watt 146 mHz transmitter can be read from 5-10 feet away. Never connect a transmitter directely to the input, to do so will damage internal circuitry and void the warranty.



Ramsey Electronics Box 4072 Rochester, N.Y. 14610 716-271-6487

WARRANTY INFORMATION

Ramsey Electronics warranty applies to original purchasers only.

KITS: All parts in kits are warranted to be free from defects for a period of 90 days from date of purchase. Suspected defective parts will be replaced promptly at no charge upon receipt for inspection at the factory. Return parts only (in suitable condition for testing) do not return entire kits. Kits returned for repair will be billed at listed repair price.

To qualify for factory repair, kits must:

1) not be assembled with acid core solder or flux
2) not be modified in any form
3) be returned in fully assembled form (inside case, fully wired, etc)
4) be accompanied by proper repair payment. No repairs will be attempted until payment is received. Payment may be check, Money Order, or charge card. No C.O.D. repairs.
5) be packed properly (insurance recommended)
6) have description of problem and legible return address packed with returned kit. Do not send separate letters. Enclose all correspondence with unit.

REPAIR CHARGES

All clock products	$7.50
Frequency counter products	$20.00
Multimeter products	$20.00
Video terminal products	$25.00
Mini kits products	$3.00

Ramsey Electronics reserves the right to refuse repair on any item.

FACTORY WIRED UNITS:: All factory wired products are warranted to be free from any defects in parts or workmanship for a period of one year from date of purchase. This warranty applies only on units that have not been modified, misused, abused or repaired by unauthorized personnel. A $3.00 return shipping and insurance remittance must accompany returned units. Pack all returns properly, insurance is recommended.

Warranty service time depends upon product, but typically runs 1-2 weeks after receipt. Most units are subjected to a burn in test to assure proper operation. Please do not cause needless delays, read all information above carefully.

RETURN FOR REFUND: Products may be returned for refund within 30 days. Refund made will be less the postage, handling and insurance charges. To qualify for a refund, the product must be returned; in orginal unassembled form (if kit), with all parts and instructions, and in suitable condition for resale.